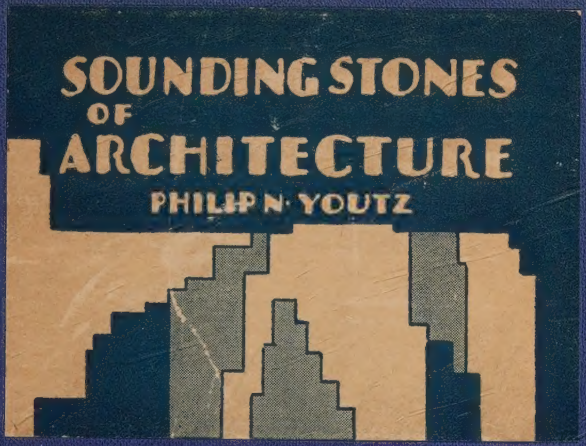
SOUNDING STONES
OF
ARCHITECTURE
PHILIP N. YOUTZ

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To

FLORENCE GILLIES

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PREFACE

NEAR a certain small village in Brittany may be seen a group of locally famous "sounding stones." To the visitor they appear very much like the other stones that line the banks of a tidal stream which flows through the hamlet. Having heard them described as the wonders of the region, he is likely to betray some disappointment on seeing them lie mutely by the water's side. But if a village father happens to be present he will explain that the stones are capable of making the most beautiful music in the world. If they lie mute it is because the visitor does not know how to play upon them. A flute or horn is no less silent to one who has not learned the art of blowing it.

Most of us spend our lives surrounded on four sides by the walls of architecture. If these walls are to us silent and confining, it is because we ourselves are untutored. For the walls of architecture are built of sounding stones which might yield rich melodies, did we but know the art. And what is true of architecture is also true of experience in general, which might be considered as an infinite opportunity for æsthetic satis-

faction. These essays describe, not limiting walls of masonry, but experience that is potentially rhythmic and harmonious, an art that sings with many voices, an instrument for the fullest and freest expression.

Architecture is used as a convenient height from which to view the relations of art and life, not as a subject for technical exposition. For one cannot look down from the vantage point of architecture without seeing what lies below framed by the deep reveals of tower windows and measured against the shadowed masses of wall and buttress. To see art and life in such a setting is to interpret them through a philosophy of textured stone and chiseled form.

Among the arts there is as much of kinship as of difference. Architecture, drama, music, painting, poetry and sculpture, all are related. The attempt to illuminate architecture will, as far as it succeeds, shed light on the other arts. Indeed in approaching them through architecture, one gains a new vista, a fresh understanding of their nature. Thus an examination of architecture may lay the foundations for a philosophy of art.

American architects have brought to youthful America the first leadership she has ever enjoyed in any fine art. For the first time she stands in a position to make an artistic contribu-

tion instead of borrowing from the rich sources of older cultures. Architecture has reached a goal toward which our other arts are eagerly pressing. This goal is artistic autonomy, a standard of excellence in the fine arts which will give America a place of equality among older nations. As long as America buys her art from abroad she will remain impoverished and a debtor.

The new architecture has brushed aside many of the time-honored formulæ of criticism. The old creed that a good design must express structure, materials and function needs a reëxamination. Architectural styles are no longer localisms but have become languages of universal expression. Architecture has been studied too narrowly with little recognition of its historical and social implications. It merits a fresh interpretation, a critical philosophy in harmony with actual practice.

The philosophy of architecture must be built with a knowledge of steel and masonry, of actual structures exposed to wind and rain, hospitably sheltering humanity and kindling its work-worn imagination anew. These essays are based chiefly on personal experience in the practice of architecture and on observations of both people and buildings in ramblings in Europe and the Orient as well as in America. Their conclusions are very tentative indeed, for they represent a first trial at mapping out a subject so old that it is

new—the beginning of an alluring study, not its completion.

Architecture is interesting from so many angles that if the critic is not on his guard, he will fall into the confusion of babbling about them all at once, an error which has beclouded much that has been written on the subject. This book has adopted the plan, therefore, of analyzing the art into its separate values and discussing only one of these in each essay. One may approach architecture in any way that suits one's particular whim or natural preference but it is well to know exactly on what this interest is based, whether it rests on æsthetic, scientific, or practical criteria.

It is easier to discuss castles in Spain than other classes of architecture because for these a literary knowledge will suffice, and one is dealing with a type of building that is a favorite with a majority of mankind. But the harder types of architecture have a vivid reality not unpleasing to the eye nor are they wholly lacking in humane qualities of civilization and association. If the latter kind of building is more difficult to analyze, still the task is far more worth the doing.

Columbia University. P. N. Y.

I

TOWERS OF BABEL

Definition

ONE of the most ancient as well as one of the most illuminating documents on architecture is the Tower of Babel story in Genesis. Embedded as it is between tables of genealogy, the account has received less attention than its due. Moreover, most commentators on the document have given it a religious or historical interpretation. They have ignored the architectural significance of an architectural account altogether.

The simple facts of the narrative, how the Babylonians said to themselves "Go to, let us make brick, and burn them throughly," and how "they had brick for stone, and slime had they for mortar," all are of curious architectural interest. They corroborate Herodotus' account of building operations in Babylon, and archæology confirms both accounts of this type of construction with bricks bedded in asphaltum.

But the chief point of the story from the architectural angle is the confusion of tongues which caused the people to leave off building. A plausible explanation of this phenomenon may be outlined in purely naturalistic terms without re-

course to so arrogant a myth as that of divine jealousy. Indeed a similar confusion of tongues takes place with nearly every successive building that we erect to this day.

The Babylonian priests conceived the tower as a great observatory from whence they might reverently spy upon their sidereal gods. The king, on the other hand, knowing that the level Mesopotamian terrain was peculiarly vulnerable to attack, felt that the tower should effectively fortify the city. The architects had molded a small clay model of what they declared would be, on a larger scale, a structure of monumental grandeur. The engineers, shrewdly estimating the loads on the soft alluvial soil, were plotting as usual to build more of the tower under ground than showed above, much to the annoyance of the other parties concerned. A delegation of business men wished the whole interior of the tower, since it was a municipal undertaking, turned into a grain elevator. Many of the oldest and most aristocratic families felt a prejudice against an attitude so grossly utilitarian and suggested that it would be more patriotic if chambers were carved out in the walls where the heroes of the empire might find a last resting place in a kind of national hall of fame.

As these many tongues—religion, militarism, architecture, engineering, business, patriotism—

became more and more shrill, and as other strange uncouth tongues of labor and purveyors of building materials from abroad broke in upon the distraught builders, the chaos and misunderstanding became general and the tower had to be abandoned. The explanation is so simple and obvious that only the greatest religious zeal or historical passion could have prevented students from seeing it.

Modern as well as ancient architecture speaks in confused tongues. Sailing into New York harbor in the soft light of early morning, one sees the city rise out of the mist, a mountain of gigantic silver cubes and pyramids sparkling like mammoth crystals, a mountain of steel and brick and stone floating on the fleeting mist that hides its base. The imagination boldly thinks of Mount Fujiyama, painted in shimmering white against the sky long before the coast of Japan is visible to the voyager. The man-made mountain is hardly dwarfed by comparison. Or one recalls Mont-Saint-Michel, a vertical pile of pinnacles, battlements, and gables, soaring from the midst of the sea, a bit of medieval magic. But Mont-Saint-Michel climbs skyward on a precipitous cliff. The modern city leaps heavenward by its own structure and power.

Masses with flat bounding planes and sharp square corners gradually emerge more and more

distinctly. The city loses its delicate picture quality and becomes hard and metallic. One ceases to dream of far-off places and gasps at the impact of reality. Entering the streets which carve deep fissures in this steel mountain, individual buildings begin to detach themselves. Each asserts its own particular function. It is a customs house, a steamship office, a bank or an oil company. These modern structures shout a vast babel of tongues, of commerce, of steel, of stone, of Brobdingnagian size, of toil, of organizations which link together countries and continents, of rude Gargantuan good spirits and energy.

What is architecture? The word suggests an oddly assorted list of buildings as famous perhaps for the fortunate events they have witnessed or their fullness of years as for architectural design. One thinks of Independence Hall in Philadelphia, of Westminster Abbey and the Tower of London, of Rheims cathedral, which fortunately neither in its prewar state nor its restoration resembles the innumerable etchings that bear its name, of the leaning Tower of Pisa, of Saint Peter's at Rome, and of the Parthenon, not against the blue sky of Greece but in a brown photograph.

Wandering away from these familiar examples of architecture, the mind recalls some

narrow street in Florence, Siena or San Gimignano or the market square at Jena or Marburg. Days of rambling in Paris, of visiting its cafés and shops, of strolling along its wide boulevards, come back with startling vividness. One lives over again the morning he set out from Paris in a tourist bus to visit the battlefields and never got beyond Meaux! Its venerable old cathedral, which was the architectural favorite of Viollet-le-Duc, offered a quiet sanctuary after the noisy bus. How comfortably could a lifetime be passed in such a village where the years are as gracious to its inhabitants and buildings as they are to its wine! Are these memories of architecture or are they memories of places and peoples and incidents? The more one mulls over the matter, the less easy it is to separate architecture from the pageantry of the life it shelters and surrounds.

In this quandary it is of no use to turn to technical books to learn what architecture is, for the answers which they expound are far from satisfying. To prate of styles and classic orders, or bold systems of space-spanning, as though these had little or no relation to the social pattern of which they are parts, is to talk of something as devoid of life as the empty skin which a snake has shed, or the rattling skeleton that once was supple and serpentine. No doubt

architects should be able to distinguish the orders, and to draw the conventional proportions that subsist in entablatures and columns, but to attempt a definition of architecture in these terms alone is thin and scholastic.

Nor do the guide books with their travelers' descriptions of buildings and their gossipy accounts of the associations and history that have grown up about them give impressions a tenth as vivid as do the structures themselves. Their writers are painters with a meager palette, or historians who have glimpsed only a thin shadow of the robust life of the past. They try in vain to translate an art of tinted stone into the black and white of literature. Though they have escaped the cold technicalities of the textbook, they have missed the vital qualities which make architecture an art.

Putting the usual guides aside, then, let us boldly explore architecture for ourselves as though taking up a very new subject instead of a very old one. As the data for this inquiry into the nature of architecture, we may start with some town or city where a representative collection of buildings is conveniently grouped together. Certainly no method could be more scientific than that of setting out along the city streets to observe real buildings. And the procedure has the merit of enabling us to view not

isolated structures marked by fame of some sort, but architecture in general.

What we see are buildings in their actual social setting, actively at work creating a throbbing urban life. Here are all kinds of structures used for dwellings, for business, for manufacture, and for public purposes. These buildings are of every style and material. A great number of them are serviceable structures occupied with trade and industry. This extremely useful and important class of architecture is rarely mentioned in books. For we have a way of writing on the arts as if compiling a social register, excluding all except those few monuments supposed to possess the highest excellence. Consequently the impression prevails that architecture consists simply of famous buildings.

The old histories were written in the same exclusive spirit. They recounted the exploits of kings and generals, forgetting that these men were great because they had subjects and armies under them. In his *Poetics*, Aristotle insists that one cannot write a drama about common men, that the playwright must have characters of heroic scale. Heroes have ever been tyrants in literature, usurping the reader's entire attention. Similarly, the monuments of architecture have always overshadowed lesser structures. But in a democratic age, we may appropriately examine

tenements as well as palaces, and shops as well as temples.

Architecture is commonly considered an art. Can the heterogeneous aggregation of buildings included in our investigation of architecture be called art? Certainly in the average urban center, relatively few structures are examples of fine art. If architecture is an art, then the term must mean something far broader than the small class of objects designed by artists.

The word art is an ancient one and has undergone frequent metempsychoses, passing from one language to another in a series of rebirths. During each of these its character has changed. In its ancient Greek incarnation, it meant *to join*, in Latin it became the word for *skill*. But in modern usage, it has become one of those omnibus words which convey a variety of meanings, so jostled together that it is hard to distinguish them. The root meaning of skill remains but the number of skills to which it is applied has increased in bewildering proportion.

Skill can best be described as an expertness which is acquired by training, and it might be contrasted with inventiveness which is an innate characteristic. The three principal types of skill are the art of the artisan, the art of the scientist, and the art of the artist. Skill blended with inventiveness enables the artisan to produce the

practical and industrial arts. Skill together with the kind of inventiveness which is often called imagination gives the scientist the power to produce the liberal arts or sciences. And skill combined with the type of inventiveness usually spoken of as creative ability endows the artist with the means of producing fine art. These three sorts of skill might be listed as practical, scientific and æsthetic. The type of art which exists for æsthetic pleasure is a blood relation of both practical and scientific art.

Taken in its whole range of meanings, the word art is practically synonymous with civilization. Civilized peoples are artists. An advanced nation is one whose inhabitants have learned a large number of skills. Its population consists of many specialized types of artisans, scientists and artists. Wherever we find it, art is a social product. Because skills are learned, the centers of civilization are always localities where large groups live together.

In order to understand a civilization, we study it through its arts. If we examine the products of art, we find that they are of three kinds: skillfully performed actions, skillfully conceived systems of thought, and skillfully made objects. For example, most of our actions, such as dressing in the morning, eating with knife and fork, driving a car, dictating or writing letters, ad-

dressing a group at lunch, reading, and playing tennis or golf, are skills that have cost us some pains to learn. They are similar to the skills of the surgeon, the violinist, the carpenter, the mechanic, for though these skills are applied to very different types of action and have attained very different degrees of development, they follow a common pattern. Action, then, is one way of expressing skills. To illustrate the second kind of art, which produces skilled thinking, one may mention any of the liberal arts and sciences, such as history, mathematics, physics, biology or philosophy. The final class, that of skillfully made objects, includes practical, industrial, decorative and fine art. In this group belongs everything made by man, from watches, hammers, and books, to buildings, paintings and sculpture.

Connected with each of these three kinds of skill or art, we have a characteristic method of comprehension. Actions take place in time and may be studied as a sequence of events recorded in history. The arts and sciences are abstract and may be studied as systems of logical and mathematical relations. Objects of practical or fine art are observed in space and may be studied as form. That is to say our understanding is either temporal, abstract or spacial.

To fully comprehend a civilization we should have to know it in these three ways. The

rhythms of social behavior, since they consist in organized actions controlled by skills, are all dominantly time rhythms. To investigate these rhythms as a sequence of recorded events gives only a partial comprehension of them. Such a time study needs to be supplemented, for the moving events we chronicle become motionless history. When we stop and examine action of any sort, it escapes us. What we outline turns out to be not a "slice of life" but an inanimate cross-section of something that once flowed in unbroken stream. Our best narration is but a convention for registering the dramatic action of social experience. Between the two there is all the difference that exists between literature and drama. History is therefore but a partial record.

A second way of comprehending social processes is to reduce them to the statistics, classifications and principles, of government, economics, and the other social sciences. This is the method of abstraction and what it does is to substitute the timeless relations of logic for actual human activity. The sciences through their inductions and generalizations present a schematic chart of social behavior, which is necessarily far different in kind from actual life. Indeed both history and science are but conventional, though very convenient, ways of symbolizing experience. Consequently both are so elusive that we feel the

need of constantly checking them with further experience.

The third way of comprehending a society is through the objects of useful and fine art which it produces. Art translates the fleeting time rhythms of social existence into abiding space rhythms. It fixes the swift motions of social behavior in static and extended form. These routines it presents not abstractly but concretely so that we can behold and study them. Thus art becomes a medium through which to examine the subtlest nuances of social conduct. Art is the objective form of civilization.

Though one must concede that the visual method of understanding culture through objects of art is partial, just as are the methods of history and science, it is in some ways the most reliable of the three. Objects of art do not have to be translated into symbols of any sort in order to be understood, because they are both a record and a part of human behavior. They also have the advantage of concreteness. As long as they endure, they are a faithful account of their makers.

But the great advantage of the spacial arts as an index to civilization is that they faithfully portray it in all its patterns, practical, scientific and æsthetic. Practical life is represented by a huge assortment of tools. For example, the

chase, which may be regarded as man's oldest occupation, is described by a long lineage of hunting weapons which lead down to the modern rifle. Agriculture is defined by such implements as the plow, the harrow, and the scythe. The industry of the present century may be analyzed through the generator, the machine tool, and such means of transportation as the motor truck, the railroad, and the steamship.

But directly or indirectly these arts also express the scientific search and attainment of knowledge. In the first place the idea which results in the making of a tool involves scientific thinking. This thinking may be highly complex as in the theory of a mammoth reflecting telescope or a skyscraper, or it may be very simple as in the principle of some minor mechanical contrivance involving little reasoning or experimentation. Secondly, practical art provides the means for controlling the physical world. It is the way we harness nature. And lastly, the use of a tool can never be regarded as merely practical, as a way of wielding physical power; to employ a tool is to learn, to probe more deeply into the way in which the world is fabricated. The difference between the practical tool and the scientific instrument is one of use.

Externally we judge the scientific development of an instrument by its degree of complication

and specialization, by the amount of control which it affords, and by the effect on the user. Any of these three ways of measurement give us as accurate a visual knowledge of the state of science among the tool-makers as would reading their history or their entire body of scientific writing. Whether we turn to history, science, or art in order to understand a people will depend on whether we desire our answer in a time sequence, a logical theory, or in the visible forms of space.

In addition to its practical and scientific uses, art may have an æsthetic appeal. Comparatively little art exists solely for æsthetic satisfaction. Usually lines of beauty are added to a serviceable practical tool. A clay vessel for holding water or wine becomes a fine Greek vase with exquisitely drawn figures. A religious symbol employed for the purpose of portraying the Madonna to the unimaginative eyes of the worshiper may become a great painting in its own right. A bank becomes a stately architectural composition with massive columns. Fine art is in many cases practical art which, happily, has the added forms of beauty.

For besides doing and knowing, man enjoys seeing and hearing, tasting and smelling, touching and manipulating, for their own sake. This delight in the form and color and other sensory

qualities of things appears to be a characteristic of all stages of civilizations, though very young and very old cultures seem to know the secrets of this enjoyment best. Fine art enriches the familiar tools of civilization, making the routine tasks of life pleasurable, quite apart from the accomplishment which they yield. Such art is the representation of the fecund patterns of civilization in space. It mirrors the beauty of our social ritual, the harmony which pervades an ordered culture.

Of all the arts, architecture most fully reflects every phase of civilization. It is an organic part of social existence. It is at once a practical art, a science, and a fine art. Thus it may be regarded as an art of representation depicting all the divergent patterns of human institutions in three-dimensional form.

By far the major portion of the architecture which we see every day exists for practical purposes only. It does a vast variety of work. It supplies the necessary tools for our social existence, the houses, shops, factories, stores, garages, offices, and mills by means of which we labor. If the eye detects some touch of beauty in its grimy surfaces, this happy circumstance may be attributed as much to the fortuitous play of light and shade as to the conscious effort of its builders. For they were too absorbed in business and

industry to think of much beside the cost of construction and maintenance, rentals and sales, floor areas and means of transportation.

If we find this architecture absorbing, it is because of what it does, not because of the way it looks. Æsthetically speaking it is meager and impoverished. But economically or sociologically, it suddenly becomes eloquent. Instead of the monotonous blocks of houses, we see workmen's homes which are more sanitary and comfortable than the manors of a few centuries ago. We admire factories as marvelous examples of the economies of mass production and standardization. We wonder at the offices and shops which give us access to the markets of the world.

If this architecture is not particularly distinguished in appearance, it nevertheless enables us to form companies, print books, live in light, well-heated rooms, sell merchandise and food, bank our money, and entertain our friends. This may be a vulgar hard-working architecture, but it is extremely livable. On a cold winter's day one can hardly ask for a more hospitable host. It watches over our work no less carefully than do we ourselves, and when the day is done, it welcomes us home at night with an affection as dependable as human devotion.

This working architecture presents a full-scale model of every industry and business in which

a particular people may be engaged. Through it we may trace all the process of production and merchandising. Here is objective data for studying and measuring civilization. These bricks and stones give us a spacial account of all the curious skills or arts which combine to make a given type of culture. To know the architecture of a people is to know the whole range of their practical arts.

But architecture is not only a tool of practical economic life. It is also a scientific instrument. Building is one way in which we exercise control over the physical world. Architecture might be considered as a method of utilizing nature. A city is a vast scientific plant for converting a crude physical environment into one favorable for human activity. It manufactures and distributes light and heat with which to ameliorate the hardships of raw climate. The progress of building, from the first crude shelters to the present precise instruments for regulating illumination and temperature, is the progress of science gradually obtaining dominance over nature.

In its own structure, architecture may be regarded as a scientific instrument for controlling materials. From being hardly more than a practical art, the structural design of buildings has gradually progressed to a science of engineering.

Any city is a demonstration of our knowledge of wood, stone, brick, terra cotta, cement, and steel. Each new structure that we undertake is an experimental attempt to extend that knowledge, and to realize the potentialities of these materials. In their structural systems, also, buildings exhibit a wide variety of scientific thinking and invention. The arch and truss which enable the engineer to roof vast spaces with structural members of easily handled size, the foundations that bear the load of forty or fifty stories, the great amount of mechanical equipment, all involve the application of intricate scientific theory.

One might also add that the use of such complicated instruments as buildings is typical of scientific method. To be sure, in architecture, these instruments are not used primarily for extending knowledge. They are applications of science. But the distinction between what is called pure science and applied science is at best a boundary that admits of no precise survey. The use of architecture for avowedly practical purposes cannot help but instruct the user and thus serve indirectly to widen his understanding.

Only after observing that architecture is dominantly practical and scientific, do we begin to pick out buildings here and there which are attractive æsthetically. Relatively few buildings

can be considered as examples of fine art, though the usually accepted definition of architecture would limit it to this small class. The definition is too artificial and too narrow, if architecture is to be interpreted as an expression of all aspects of civilization. Moreover, it tends to overlook the sound, practical basis of nearly all architectural fine art.

But we may make our peace with the old definition by admitting that in the best architecture the builder has not been content merely to build for stark utility. He has translated the necessary patterns of practical life into the rhythmic forms of spacial art. Beginning with practical requirements he has risen to the creative expression of the great artist. He has used architecture as a medium for interpreting the formal beauty of society.

In architecture, the artist is concerned with many conflicting values. He is never free to develop his conceptions as his genius may direct. He must recognize certain inevitable limitations of function, materials, and structure. High artistic ability is needed to enable him to weld these elements into a unified design, or to make of his limitations actual creative opportunities. For architecture is an art in which the artist must struggle for mastery and can only win dominance by the sheer strength of his imagination.

As fine art, architecture is an original composition of masses, planes and lines into a three-dimensional pattern in space. The artist or architect works out his design in terms of form, symmetry, proportion and shadow, which accent every architectural recess, every break in the smooth contour of a plane. Architecture as an art of design, is a kind of sculpture unhampered by the meager vocabulary of the forms of man and beast; not a sculpture of restless roving bodies, but one of repose, of strong materials in equilibrium, of statics. Here is a sculpture where heroic size is the rule and where imposing perspectives give the art an epic setting.

This brief analysis of architecture has prepared the way for a general definition. Architecture is the lithic form of civilization. It is a vital expression of the whole range of human activity; it reflects all the intricate patterns of human organization. Buildings are as complex and diverse as the society for which they provide shelter and expression. Structures of architecture are Towers of Babel because they voice all the conflicting tongues of our group existence.

This definition suggests a new way of approaching architecture and the other fine arts. Instead of regarding art as an isolated matter of masterpieces and schools, it may be viewed as

a record of cultural development. Art is integrated with the growth of civilization, never isolated from it. Through their painting and sculpture we may behold a people, through architecture their social institutions, through the minor arts their domestic and industrial life. Thus the rich accumulation of art may be considered as data for understanding the social, economic, political, and intellectual advancement of a given time.

The significance of the arts as an index to the patterns of social life was first made explicit by the sciences of anthropology and archæology. The study of man before the advent of writing demonstrated that man painted and carved and built a record of his life which was no less plain than the later inscription or book. This visual account proved in many ways a safer guide than the written one. For, left to compose his own narrative, man inevitably writes what he thinks or wishes, not a treatise dictated by facts. The arts, on the other hand, exhibit human behavior objectively and without interpretation.

Where a period has a well developed literature, the arts furnish an invaluable means of comparative study. In history we have the temporal patterns, in the sciences the logical patterns, and in the arts the spacial patterns of

civilization. With these three means of knowledge we are able to check the assertions of one against those of another. But more illuminating still, we are able to take the same group of social phenomena and examine them in temporal, logical and spacial terms, watching their transformations. In order to know a particular period, one must be a historian, a philosopher, and an artist. Our usual attempts to deal with a culture in terms of but one of these methods, and then only through some subdivision of it, is very like the method of the man who in order to see better put out one of his eyes.

Knowledge has become so bulky that it has fallen apart by its own weight. A chief educational problem of our century is to discover some means of putting all we know together again. The student wanders bewilderedly from one department to another, experiencing all the impediments to progress which the pilgrim of medieval days encountered when within a single journey he had to make his way through numerous hostile kingdoms. The arts seem to offer a body of material sufficiently concrete and substantial to bond history and thought together once more. Times seem to be ripe for attempting a new type of history of art, one in which art is considered in all three of its meanings, as skilled actions or history, as systems of knowl-

edge or sciences, and as objects in space, or tools and fine art. Such a conception of art might be the starting point for a synthesis of knowledge. And one could hardly ask for plainer or more visible guide posts for such a tour than the objects of art themselves.

Whether or not so bold an attempt to see civilization as a whole is feasible, one might at least begin by trying to see the relation of the fine arts to the practical arts. Both types of art are products of the same social order, both are the result of similar types of skill. The tool is no less a creation than the sculptured figure which exists only to be seen. A good beginning toward seeing these two branches of the arts together may be made by an investigation of architecture in which they are both so happily combined.

The purist will always regard with suspicion any attempt to do aught but look at art. Though one may readily agree with him that, in so far as objects are fine art, they should be appreciated and appraised in purely sensory terms quite aside from use, subject-matter, associations, rarity, or age, there is no good reason why our concern with art should be limited to æsthetic contemplation. As a matter of fact, except during moments of rapt attention, our minds take a lively interest in a variety of features

which have nothing to do with fine art as such. We inquire as to the architect, the period, the purpose of the building, and even as to the price.

The important point seems to be to know just which aspect or value one is talking about on a given occasion so as not to fall into the confusion of babbling about them all at once. If we are to consider architecture as echoing all the different voices of civilization, our problem will be to separate these and interpret them one at a time. For each expresses a different type of accomplishment in the repertoire of human skill. Taken singly they may be readily comprehended, though to attempt to understand them all at once is sure to lead to the old babel of tongues.

In analyzing architecture we may conveniently select certain typical aspects. These will give us an outline of its characteristics as well as would an exhaustive list. Since works of architecture are so often spoken of as monuments, we may begin with *history* as our first aspect. The practical importance of buildings is so great that *function* would naturally come next. The engineering side of architecture may be listed under the head of *structure*. Following these we may mention the decorative or æsthetic qualities of *materials*. And no analysis would be complete that did not include *style*,

the ritual part of architectural composition, and *design,* its creative part. As a final aspect we may choose *construction,* though we might mention others.

In examining these values, we notice at once that they are so contrasted as hardly to belong on the same list. They seem to refer to things that have little or no relation. Yet in the end, when we have learned to distinguish and understand these conflicting tongues, the confusion may disappear. We may discover that the sounding stones of architecture sing in chorus, that the silent harmonies of this music can be heard only by an ear attuned to them all.

As we progress with our analysis, we will notice that we are actually asking the question, "What is architecture?" in a number of different languages. In each case the answer is formulated in exactly the same language in which the question is asked. And as far as it goes each of these answers is a complete and adequate one. This explains why architecture may be so many things at once. Thus the man who seeks to learn what use architecture serves will always discover his answer solely in terms of function. The artist who asks what the visual features of architecture are will find that they are style and design expressed in certain materials. And the builder who wants to know how architecture is

made, will decide that it consists of arched masonry or other types of construction.

From this analysis we may hope to derive some insight into the relationships of our three characteristic types of experience, practical, scientific, and æsthetic. Regarded from the points of view of function and construction, architecture is a useful tool and a typically practical undertaking. Taken as history or structure, it is science—if we may here use this word to apply to all types of knowledge—for the one has to do with the accurate account of human development, and the other with the structural relation and control of materials. And studied in terms of the visual qualities of materials, and as style and design, architecture is fine art, for it is occupied with purely æsthetic problems. The study of architecture in all its aspects may thus give us a perspective of life itself.

II

VISUAL HISTORY

Symbolism

ARCHITECTURE is the visual aspect of history. It is the outward appearance of the institutions, habitations and social life of a people. The temple is the way the eye sees religion, the fortress the way it beholds militarism. Architecture is the way history looks. It is the shell or external skeleton of civilization.

Possibly one cannot see all by gazing on the skeleton. The living organism is more than its durable remains. Yet the trained observer can reconstruct the elusive outlines of former life with amazing accuracy. Architecture is a book of history which must be studied diligently before the page is plain. Many passages remain obscure. The lines are packed with implication. But in these respects it differs little from written history.

For in history it is hard to tell when one is gazing in a mirror and when one sees an actual picture of the past. The image of the present protrudes itself into the past in amazing ways. Is the Socrates we know to-day more a citizen of the twentieth century or a portrait left us by

Plato, Aristophanes and Xenophon? And is the composite portrait which they left much like the homely sculptor-philosopher who was their teacher? Mirror or picture, who can distinguish in reading history?

Yet though we admit that the present is the author of the past in a double and equivocal sense, some history is more authentic than the rest. As history, architecture is particularly objective and verifiable. Indeed one might argue with much sound logic that it is the only possible type of history, that all else is myth. The written record is perishable. It rests on the fragile testimony of witnesses. The events it records and the institutions which it describes can now no longer be established with any certainty. Written history is a tenuous tradition, an Ariadne's thread leading back through the labyrinth of time.

As long as one places faith in documents and written words, history walks proudly. But let skepticism start with a contemporary record, or the lying testimony of some eyewitness, and the whole pompous structure of history falls. Whether its value to us is that of fiction or whether it has a solider basis we may never be able to prove. In the last analysis all written history is a kind of dogma, a record of belief, not of fact that admits of proof. As dogma, writ-

ten history becomes a branch of theology. It is our creed regarding the past, and in so far as it rests on written record alone, it is of one and the same pattern as the story of Adam and Eve.

Science insists that facts rest, not on past authority, but on present observation and future experiment. Indeed the scientific spirit is by implication quite as hostile to written history as to any other type of theology. To make written history seem scientific and give historians the status of scientists, it is now considered good form to make frequent predatory raids on the sciences for facts. Most of these facts are pilfered from geology and astronomy—both of which are very handy when it comes to dates, though the former is apt to deal in millenniums instead of centuries—and from paleontology anthropology, archæology, and architecture. An archæologist, it may be explained, is an architect of a kind, but he is one who prefers crumbling old buildings to new ones of his own. He is a re-creative, not a creative, worker, though he is very much of an artist in an antiquarian way.

Of all these sciences which history preys upon, architecture and its antiquarian branch are by far the most important. They furnish the true history of man, a record that is intimate and human yet scientifically impersonal, one that is

written with no predilection for any hypothesis or interpretation. Here is history as definite and accurate in outline as any feature of the present. Well laid stone admits of no skepticism. As long as it stands, it stands. Indeed, as long as it bears the mark of the chisel, it is the surety of the fact.

Architecture, then, is not mere visual history. It is a humanly recorded history that will bear the test of science. This is one of the greatest values of architecture. We build, not write, the record of our institutions and our lives. The architect is far more reliable than the librarian and his books. He contrives adroitly to record both the dream life and the practical accomplishments of mankind, for he is both an artist and a builder.

What is the nature of this history? What does it record? It covers the whole social and æsthetic life of a people in minute detail. Politics, sociology, economics, religion, art—all these have their place in the account. But architecture presents a somewhat different range of facts from that of history books. The Florentine palaces give us a picture of renaissance life as accurate as a photograph, but beneath the picture there is no caption, no narrative account. Here are no quaint stories, no anecdotes, such as adorn the pages of written history.

But the chief difference between architecture

and the written narrative of history is that architecture for the most part tells of people, not of persons. The streets of excavated Pompeii give us a vivid glimpse of the social life, of the economic and political institutions of this Romanized Greek colony. Thucydides could hardly have done better. What we miss is the individual persons walking the streets, toga clad, ruling, marketing, quarreling, conversing. We may see the frescoes which they looked at as they ate or toiled, but not their individual faces. There is little personal biography in architectural history. Now and then a workman will carve his own head on his work, or a sculptured frieze will give the account of a ruler's progress. Usually, though, we discern a standard and pattern of living but not the living people.

This may be due to the fact that architecture is ever the offspring of organized human effort. It is the symbol of coöperative accomplishment. So it records not a single author but the society which produced it. The soldier, the trader, the ruler, the herdsman and farmer, as well as the workman who toiled on the building, merit the credit of the monument. For directly or indirectly they contributed to the wealth, security, or food supply which were necessary conditions of its achievement. Architecture is always municipal, provincial or national, never the work

of an individual. Not Michelangelo but the whole renaissance produced the dome of Saint Peter's.

Architecture depicts the institution, not the human parts of which it is made. The monastery we may study and know, but not the forgotten monks who once dwelled there. If a few great names linger by reason of their giant stature, they are those of the leaders in the enterprise, not its sole authors. And many a noble pile gives us no clue whatever to its architect or patron. Often the local king or nobleman claims the credit for buildings with which he had no connection except the accident of contemporaneousness. The guild hall, the monastery, the feudal castle, the cathedral, and the palace give us a view of medieval life which in its way is as detailed as any written record, but few names would survive by architecture alone.

Much of the pleasure of European travel lies in the visual record of history which the architecture affords. American cities for the most part speak only of the present which is familiar and commonplace. But older cities on every street and alley have some ancient mansion which speaks eloquently of bygone centuries. The irony of the memorial tablet is that after its own generation has disappeared it ceases to call up an image of the past to the beholder. How differ-

ent is architecture! Its turreted walls and arched gateways give the actual setting, and if the actors do not stride forth, this is the fault of one's own imagination.

The old cities of Europe are books of history familiar to their own inhabitants and to every traveler. The past gives a distinctive quality to continental life. Here in America figures move rapidly but always in the present and the future. Motion is accelerated but restricted. Here we enact the flat, single plane drama of the cinema, and even the best artistry cannot conceal the shallowness of the screen. European life on the other hand takes place on a stage in which the past gives depth and significance to the drama. Living takes on a deeper rhythm, a more certain direction. For it is steered by a rudder that is ever in the past.

One of the most eloquent architectural histories in all Europe is that of the little town of Périgueux in southern France. Périgueux is striking because the chapters in her history are so clearly marked. Chapter one must begin very near to the time of Adam himself. Indeed the fruit-laden countryside offers much sound evidence for the hypothesis that this was the original garden of Eden. Only occasional tourists find their boisterous way to this quiet spot, and these are mostly French travelers exploring the

vastness of their own small republic. The warm sun has lulled this countryside to a gentle drowsiness, so that centuries slip by as little noticed as years in other climes. The inhabitants are a hospitable sort, well content that fate has cast their lot where nature is so generous an ally. Apparently people live to a prodigious age and doctors are more in the nature of professional friends than necessary agents of protection.

In the soft limestone cliffs along the river near the city are numerous natural caves which have been used more or less continuously since the Stone Age, perhaps fifty thousand years ago. Many of these caves are still used as homes and wine vaults.

A short ride from Périgueux, the hamlet of Les Eyzies hides beneath overhanging bluffs at the junction of three rivers. Here is the most ancient of all man's architecture found in the rock itself in innumerable caves and galleries made by many natural grottoes. A brooding air of antiquity pervades the whole district which was once the habitation of dawn man. His spirit lingers at this meeting place of rivers. The tens of thousands of years since he dwelled there fade as one approaches, and his presence seems vividly actual.

Pondering over this shaggy-browed, hairy-armed ancestor who must have been so near akin

to the beast he hunted, one enters a long low cave guided by a flickering candle and the flowing accents of an unseen peasant-guide in the dark beyond. Suddenly stopping before a smooth part of the cave wall, one is astounded to find that these Stone Age men were not brutes, but artists! Here are bold sweeping drawings of bison, mammoths, tigers, bears, horses, deer, rhinoceri—animals, many of which have not inhabited Europe for thousands of years.

The cave architecture, the drawings and the rudely flaked flint instruments of these early artists make up the first chapter of the book of Périgueux. It is a chapter that rivals the book of Genesis, both in interest and, one suspects, in antiquity. Nor does the primitive account, written by the people themselves, appear to have been edited or revised in any way by later critics.

Between the first chapter and the second a long interval of time is supposed to intervene. There may be some written accounts of the period when the tribes of gallant Gauls who resisted Cæsar so fiercely, dwelled here. But about this period and those which immediately preceded it, architecture is silent, for the people of these times did not record their history in stone.

The second chapter opens with Périgueux as a Roman provincial city of considerable importance. The Roman city still stands beside the

modern one. In the midst of its ruins rises a high cylindrical tower, most likely a granary, the classic ancestor of our modern grain elevators. It resembles these later structures also in being constructed of concrete, though the exterior is faced with small cut stone. Perhaps here were stored the corn levies which were sent to feed the poorer citizenry of Rome at the expense of the empire.

Nearby is the amphitheater where a warlike people delighted to see deeds of strength and skill in combat between men and beasts or even between the gladiators themselves. In some parts of France, for example at Nîmes, these ancient amphitheaters are still the scenes of bull fights, a blood-thirsty sport very Roman in character. But here at Périgueux the amphitheater is a quiet garden where grandparents and small children while away the afternoons. The dark caverns beneath the seats where once the savage beasts were caged until the time of combat are now overrun with ivy.

The Romanesque, too, has bequeathed to Périgueux a diary in stone, and this will serve as chapter three. An ancient Romanesque church, St. Etienne, stands not far from the Roman city. The aged building, some parts of which may be traced back as far as the first quarter of the twelfth century, gives evidence of having been

altered frequently during succeeding periods. It seems to have made concessions to every age, yet still contrived to retain an air of antique dignity. If a ramble about this battered pile seems too short a chapter, one should supplement it with a visit to the nearby city of Poitiers where there are many remains of the eleventh and twelfth centuries as well as of earlier times. At Poitiers is the most picturesque of all Romanesque remains, the church of Notre Dame la Grande, and near it the miracle-working church of Sainte Radegonde and the venerable Merovingian baptistry, much older than either. These will do very well for additional reading at the end of chapters three and four of the book of Périgueux; and with them one might desert architecture long enough to enjoy a good translation of the Chanson de Roland with its flavor of medieval life and its accounts of stern Norman knights.

The fourth chapter in the book of Périgueux is Byzantine-romanesque which recalls the medieval city of the twelfth century. The cathedral of Saint Front which is, it must be confessed, an uninteresting restoration by Viollet-le-Duc, is a milestone in an ancient trade route that reached from Byzantium. It is of the same type as Santa Sophia, that Eastern enchantment of soaring domes and semidomes. The style of Santa

Sophia was first brought to Venice and used in building San Marco of the jeweled mosaics. From San Marco the plan made its way to Périgueux where the low domes look oddly Eastern.

The fifth chapter in the book of Périgueux is Gothic, and for this we may take the ancient half-timbered houses of the old city. Their low-beamed chambers and mighty fireplaces will tell us something of domestic life in France when the great cathedral builders were at work. In its humble, homely way, this Gothic architecture of wood is as worthy of attention as the grander monuments of stone. Perhaps it was the memory of such oak-framed houses that the Norman conquerors took from France to England. How stanch these timbered habitations are! The rent which the householder must pay to time and weather in the way of repairs is negligible—now and then a new slate for the roof or a bit of plastering between the dark oak timbering.

For the last decades of the Gothic in Périgueux a ruined stone château is a quaint reminder. Only its shattered walls now are standing and its hall is grown with grass. The hearths of its fireplaces have fallen, leaving the carved mantels perched high upon the walls. The château must have been the seat of a family of distinction. Probably the fury of the Huguenots destroyed it together with its owners.

Chapter six of the book of Périgueux shows us the renaissance with its classic pilasters carved with delicate candelabra and vase or floral forms by some itinerant Italian workman. This is the way the France of Rabelais and Montaigne looked. In these halls Rabelaisian feasts, whole bakeshops of French pastries, prodigious oxen roasted on creaking spits, and hogsheads of wine were consumed by bold Gargantuans. And no doubt the tales that were told between hiccups and draughts of wine were as gross and extravagant as those related by Rabelais. What times these were, the crossroads between antiquity and modernity! Montaigne, in his quiet study, reveling in the classics, is equally excited over the newly discovered peoples of America. Classicism vies with discovery for popular attention, a tournament between past and future.

The final chapter is being written now by a modern city full of municipal pride in its public squares, its dully designed museum of antiquities, its theater, and its semi-modern improvements. No other city has its history more charmingly written. Few leaves have been torn out or defaced by later work, as is the case with so many early manuscripts of which the original writing has been erased so that some frugal monk might copy his Christian treatise, thus obliterating a dim classic of the pagan world.

Architecture may seem a strange history to the person accustomed to the hero worship that still characterizes books. Show us the people of the past, not their work, say these readers of history. Gothic architecture is crowded with people. If the majority of them are Biblical and somewhat remote saints, the models for these personages of the other world were the men and women of the stone cutter's local acquaintance. In Gothic art God and his Son were carved in the image of man, in spite of medieval dogmas to the contrary.

In this way many who were very far from fame or sainthood found themselves sculptured on the cathedral. This may have been appropriate, for the cathedral was often more a municipal undertaking than the work of the church. The church simply supplied the channel for municipal pride and energy. In another generation the same spirit would have constructed magnificent earthly bridges, lavish town halls, theaters or hospitals. As a consequence the cathedral had to represent all of these secular interests as well as those of the other world. The duty of the municipality extended to giving its citizens their full rights in the life to come as well as in the present life.

Where the monastic spirit prevailed, as at Chartres, the saints grow long and emaciated be-

yond any possible architectural requirement. Here the monkish ideal of the good life is everywhere dominant. But journey to Amiens, a cathedral which as far as windows and vaulting are concerned is far more light and ethereal than Chartres, and notice the shocking transformation in the figures. At Amiens the saints are all substantial burgers, many of them positively obese. For Amiens is a secular cathedral wherein the good life and good living are one.

Here, too, is one of the most notable pageants of the middle ages, done not in stone, but in mellow oak. The choir stalls of Amiens present just such a varied and goodly company of people as do the Canterbury Tales. These are an architectural rival of Chaucer. The grotesque but shrewdly apt likenesses of the small figures which swarm over the choir stalls match a poet's words in vividness of description. Here is the turbulent life of Amiens as it was lived centuries ago. The polished oak conveys the illusion of life far more effectively than an inorganic material. On one arm rest sits the battered figure of the architect bending over his square and plan. Perhaps his face was already battered thus in life by the unruly factions he had to govern in the execution of the cathedral. At any rate the poor man's face is now unrecognizable. Near him are artisans, while in other groups merchants and

gentry argue over old differences more in the spirit of the marketplace than of the church. If it has been a market day in the town and one visits both mart and place of worship, the similarity is unmistakable.

Or would you gaze up at the faces of the rulers of the past, journey over to Rheims which is now happily restored from its war-ruined condition. Above the great rose window of the lofty façade stands the noble company of the kings of France marshaled in an imposing row beneath a high arcade of pointed arches. In the deep reveals of the three mighty portals hundreds of saints find shelter far below the feet of the kings. Is this architectural, or is it sculptured history? Architecture and sculpture are more closely related than the other arts: the kinship of the two may permit of some license in the borrowing of each other's goods.

So far visual history has been treated as a literal rendering of the past. But architecture may also be a more abstract symbol of history. The great merit of a symbol is that it gives a solid foundation to much that is vague or hidden. The symbol illuminates what the mind can only dimly grasp. Some will urge that this is a chief function of architecture, and that symbolic history is far more important than that more strictly delimited by fact. Both have their uses

and abuses. The symbol awakens the imagination, but it is also a logical instrument, and even in its less strict uses it may be the vehicle of a concept not easily confined in language.

One of the most revealing architectural symbols is the early basilican church. A good many of these but partially Christianized places of worship still stand in Rome and two very interesting ones at Ravenna. The basilica, with its long rectangular hall flanked by aisles on either side and terminating in a semicircular apse, is supposed to be modeled on the Roman law court. The spiritual court copies the secular court. In the case of Santa Maria Maggiore at Rome, some evidence exists for believing that the edifice may have been originally built for the purpose of litigation rather than of worship. The nave or main portion of the church terminates in a Roman triumphal arch, a symbol fittingly appropriated for the King of kings. But between this arch and the semicircular apse runs the bema where the judges may have sat in Roman times and which at a later day became the transepts and crossing of the cathedral.

The single or double aisles are separated by a colonnade which carries the clear or light story and roof. And these are most significant factors in the symbolism. For these fine marble columns were in most cases quarried from Roman temples

or other buildings. Often the columns salvaged from earlier structures do not match, or they are too short and must be lengthened by a stilt block. In the earlier Christian basilicas the columns usually bear classic entablatures which also may exhibit the varied designs of their different sources. But the supply of pagan temples to be wrecked for the glory of God seems to have been exhausted so that for the later churches it became necessary to use arches to span the space between columns instead of horizontal architrave, frieze and cornice.

The more one studies early Christianity the more one realizes that the architects of the basilicas have done exactly what St. Augustine did, selected and combined material from many sources to produce a synthetic world religion. St. Augustine's task as a theologian was to unite an eastern folk religion of faith with Hellenistic philosophy, particularly Neoplatonism, and to organize a church along practical Roman lines. The result is a mosaic of singular beauty, for it was Augustine's genius to choose the best elements from all his sources and give them unity and power. Only the scholar and a few devout souls will read St. Augustine's works to-day or have the curiosity to look into his sources. But any traveler may at a glance take in the outlines of his work by visiting S. Apollinare in Classe at

Ravenna, or S. Lorenzo fuori le Mura, the twin-church at Rome.

Indeed the symbolism may be pushed further with profit. The mosaics which decorate the spandrels of the triumphal arches and the half domes over the apses are eastern. These, and the figures of Christ, of sheep and of angels, which they depict, are eastern conceptions. The Roman plan, the Greek columns and entablature, and the eastern mosaic are symbols of the three principal sources of historical Christianity. A study of the carving and iconography would enrich the symbolism much more.

Architectural symbolism may be of two kinds. It may be a direct symbol in which a part may stand for a whole, or it may be an indirect symbol which is chosen quite arbitrarily so that it has no necessary relation to the thing to which it refers. The early Christian church represents a part of the same process that produced the thinking of St. Augustine. It is therefore a direct symbol. On the other hand, a building which is dedicated as a memorial is an example of the indirect and arbitrary use of architectural symbolism. Architecture assumes its value as history primarily because of its direct symbolism, because it offers in objective form a representative sample of the pattern of its contemporary culture. The object of a building's fortuitous

symbolism, to commemorate a victory or a great name, may be preserved by its enduring structure, but this is an external association, whereas the plan, the design, and the construction are an intrinsic part of the times which produced them.

The great importance of visual history is that it is so much a product of and hence an index to the whole range of civilization. The art, industry, religion, politics, and commerce of a people all may plainly be read in the mounting walls and towers of their architecture. Of all the symbols of history architecture is the most complete, for it is history presented from many angles, and its extension to more abstract phases of culture is fraught with little danger of error. The anthropomorphic symbol, the hero or king, is apt to become the progenitor of a myth that generations of careful research can hardly depose. Indeed, part and parcel of the divine right of kings has been myth-making, the propagating of false notions to tyrannize over human thought. The architectural symbol has a franker nature. Its honest stones are there as reminders of the literal truth which is the starting point for any inference or hypothesis.

Architecture differs from other history because it presents a behaviorism of social groups. The old written history was subjective and introspective. It ascribed motives and thoughts

which could not be tested or corroborated. Architecture follows the same first principles as behavioristic psychology. The history it records may be observed and checked and re-checked. Not even the most scientific of modern written history can approach the objectivity of the architectural record. As history, architecture is pure science.

But history is not alone in having to guard against human bias. Sociology has always had a more baffling problem than the other sciences. Its difficulty has been largely that of determining how to go at its work, how to deal with the puzzling phenomena of social behavior in a detached and clear-headed way. While it was easy enough, if one knew the technique, to measure and count molecules, atoms and electrons, human beings proved to be more perverse material. Nor could the investigator quite forget that he was dealing with his own kindred. He was handicapped like the doctor operating on one of his own family. Personal feeling crept in constantly.

Architecture, both ancient and modern, reveals a method by which social behavior may be mapped concisely and intelligibly. Let the sociologists all turn architects and take up the study of human institutions through their lithic shells as the paleontologist studies fossils. For

ancient architecture, the archæologist has already mapped out a useful method. The modern field has scarcely been touched. Instead of conjecturing about institutions from the inside, let the student view them clearly from without. Architecture, the stony skeleton of social life, offers a key to its structure and functions. The study of architecture enables us to get outside ourselves.

For history, time is an all important category. The wonders of one century become the commonplaces of the next. The task is ever to run down the parentage of events so that the offspring will not be falsely described as the progenitor. History is not a catalogue of discrete events. Rather it is a drama that, to be intelligible, must be enacted in exact chronological order. If history has a thread, it is time which gives sequence and relation to events. History can only be understood as a comparative analysis, a way of contrasting what has gone before with what has followed.

Time is the fourth dimension in architecture. This is particularly true of mellowing materials. But it is equally true in the historical sense. We are interested in architecture precisely because every architectural monument is a milestone marking a stage in human memory. Though we often copy and try to retrace our past, we

never succeed except in a superficial sense. Our buildings need no dates chiseled in their corner stones. They bear the dating of the times that produce them.

To be sure, history would be less difficult for the novice if each age evolved and followed a style unlike that of any other. But the history of style in architecture is one long confession of imperfect mimicry in spacial expression. The Greeks may have copied the column from the Egyptians. The Romans copied the Greeks. The medieval Romanesque style, as the name implies, was a rude copy of Roman work. Gothic architecture copied Romanesque. Then came the renaissance which recopied Greek and Roman styles. So we might continue to the present, showing that no style has ever been autonomous. Our present incurable classicism is but the symptom of a chronic disease common to spoken and spacial language, not a new affliction.

Architecture places the centuries side by side so that the proportion or ratio which we commonly call progress is readily seen. Here is the fascination of Périgueux or any ancient city. Side by side on opposite pages of history we may look at the twelfth century and the fifteenth, the Gothic and the renaissance. Seen together they have meaning and relationship. We may see the

path our ancestors trod and the byways and blind alleys on which they so often turned aside.

While the precise year of works of architecture is often baffling, the century is rarely in doubt. Usually it is written all over the façade in a style too marked to be mistaken even by the amateur. This in itself is of the greatest historical importance. For the undated record loses nine-tenths of its value. It is a floating fact unanchored to the past.

In written history there seems no good way of coloring the separate centuries so unmistakably that they will stay apart. To most of us the ordeal of ordering up the centuries since Homer, in a neat, well-arranged sequence, ends in defeat. But with a history of architecture under our arm to give us the landmarks, most of the centuries become characteristically distinct. All we need is the eye to aid the memory. The sight of a familiar building recalls the fading recollection of the road.

But the real genius of architectural history is in providing the possibility of comparative study. In no way else can we see the relation of periods remote from each other. The Tower of London standing in the midst of the modern city shows a contrast that is as striking as it is important. Notre Dame in Paris is more than a church. It is a date. It is the essence of a

century conveniently preserved for all time. We may compare it with Sainte Chapelle, begun a hundred years later, and see the vast difference between the twelfth and thirteenth centuries.

Just as time and space are now united by philosophy in one category, so in history they are closely joined. The historian must not only date his civilizations but he must show how they are diffused to remote parts of the world. He is interested in the spread of the arts from the time Prometheus stole the fire until the last practical invention was copied by one country from another. Culture diffusion is the name for the way in which nations learn from each other. Some scholars go so far as to assert that in early times, at least, nations only learned through the tutelage of others, that invention was beyond their powers.

By what stages did Greek culture travel through Rome and Byzantium to our own times? What is the roundabout and devious genealogy of contemporary thought? What paths has civilization followed? The guide post to the march of civilization on civilization is architecture.

Who conquered, the victor or the despoiled? The answer may be seen in the architecture that prevailed. How strong was the power of the Saracen in Europe? The answer is the Alhambra. How thorough was the conquest of the

Norman knights in England? Durham cathedral is the full measure of their power.

To the architect, guide books to Europe are superfluous paper aside from some practical advice about highways and hostelries. For the ancient routes by which new learning spread from one nation to another may all be followed in the design of church and manor. If the road has been crossed and retraced again, the footsteps which mark culture diffusion are still plainly imprinted in the stone. No nation can borrow, however stealthily, or lend in turn, and escape the architect's spying eye.

For each nation and each century leaves its own signature upon its architecture, as characteristic as any handwriting. The ax work of the Norman, the flaming design of later French Gothic, the garlands and fruits of the renaissance, all these and subtler marks identify the originator. Architecture is the autobiography of the human race written with its own hand in characters of lasting beauty and significance. It is the supreme historical record of human social achievement. Architecture is the memory of civilization.

III

TOOLS OF STONE

Function

THE recorder of the Tower of Babel story was an extreme functionalist. His only description of the tower states that its top was to reach to heaven. He evinces not the slightest interest in the architectural design. What impressed him especially was the purpose which the tower was to serve.

The Tower of Babel was a sky-tool. It was a scientific instrument for piercing the mystery of the star realm. It was a kind of telescope by which man might probe with his naked eye into celestial secrets. Many centuries before Ptolemy, Copernicus, and Galileo, these Babylonian scientists attempted the construction of a mighty scientific tool that would bring them knowledge and control. Small wonder if their gods were jealous and in their righteous wrath cursed architecture with a confusion of tongues from which it has never recovered. For they recognized that architecture was the first instrument by which science sought to make gods of feeble men.

To regard a work of architecture as a tool may seem somewhat novel. Holding down these pa-

pers as they are written is a crude stone chisel from the prehistoric cave city at Les Eyzies in southern France. This ancient chisel with its edge dulled by use is the type of tool which primitive man employed during the thousands of years of the Stone Age. Buildings also are tools. To be sure these tools of stone are highly developed compared with the rudely chipped flint instrument. Their functions are extremely complicated and specialized. Yet they differ only in degree of adaptation and intricacy from the implements of earliest savagery.

To compare tools that have similar functions, strictly architectural implements of the Stone Age are by no means lacking. In Brittany near the hamlet of Le Guildo, for example, the visitor may search out an *allée couverte,* a low corridor with walls and covering of enormous unhewn stones, built when the majority of man's instruments were stone.

Architectural tools of steel are innovations that have come in the lifetime of our own generation. Most of our architecture is still a kind of anachronism in stone, a hangover from prehistoric times. The use of metal has been restricted, because of its cost, to our smaller instruments. Until very recently our architectural implements have been of cruder materials and have borne the marks of hand manufacture.

The architect recognizes the functional character of architecture in the attention he gives to the plan of his buildings. In elevations and perspectives the design elements may dominate, but plans reveal the uses which buildings serve. The plan is a drawing of the tool and shows how it is to work.

What is a tool? In the broadest sense it is anything by means of which man multiplies his power. Thus the syllogism is a logical tool, the saw a carpenter's tool, human beings the executive's tools, and buildings the universal tools of practically all mankind. Tools are inventions by which man seeks to overcome his weakness. They are as various as the types of human endeavor.

The tool is a means of modifying the relation between man and his environment. It changes this from one of impotence and acquiescence, to one of power and control. Early man lived in a natural world that he accepted as he found it. Civilized man lives in an artificial world that he himself has made. The tool is the lever of Archimedes by means of which a man-made world has been raised above a natural one.

The specific function of tools is to accomplish work which would be more difficult or impossible without them. One has only to consider how arduous is locomotion on foot as compared

to locomotion on wheels, or copying by hand as compared with printing by machine, to perceive how greatly tools augment human capacity. They enable the laborer to reap a reward of his toil that is many hundredfold what his unaided efforts could produce.

The use of tools is not only a way of working; it is also a way of thinking. One cannot be a user of tools without also being a maker of them. Their principle must be grasped, their construction understood. Their operation suggests improvements. Tools teach skill of both hand and brain. Their user is always an apprentice receiving instruction in his craft.

Handling tools is a way of knowing the world. The tool is our means of exploration. The only way in which we can understand the objects of ordinary experience is through tools. The only kind of learning is by doing. Our car teaches us the surrounding country; a boat reveals the nature of the sea. These are instruments for probing into the secrets of nature as truly as are the microscope, the seismograph, or the barometer.

The nature of the tool depends both on the worker and on the work performed. Its excellence is always relative to a particular situation. To judge it we must know its use. For a people living in the friendly climate of Japan,

the economical frame house with fragile paper screen walls is admirable. But how useless would such a tool be in New Hampshire or Vermont!

What do tools do? Their general function is to create civilization. They not only manufacture the products required by an advanced society but they teach the many skills which combine to make the social pattern. Civilization may be said to have begun with the invention of the first tool. Whether this was an implement of stone for hunting or whether it was a rude hut of leaves for shelter, its discovery was the greatest that has ever been made. It was a first step on the road to knowledge.

The history of architecture is synonymous with the history of social development because it describes the gradual improvement of buildings as tools. Plans record fairly accurately the culture level of a people. Buildings which are all-purpose tools belong to a very low society. Like the omnipresent hammer, ax, chisel, and knife, they go back to prehistoric times.

In excavating an ancient city, the archæologist is often at loss to tell precisely how the former inhabitants employed the rambling galleries and chambers which once more are brought to light. They might have served almost equally well economic, religious, political, or military needs, so little are they specialized. The builders

of ancient times knew little about making their structures keen social tools. Plans tended to be rather formal and traditional. Rooms varied little in size or shape to conform to the needs they served. There was little experimentation in adapting buildings more adequately to man's use. Structural requirements very seriously limited the early builder's freedom in planning. And the society which employed his tools was less complex and more simple in its needs.

Probably the first specialized building was the hut or house and after that the temple. The palace is a variant of the house, a sort of rich relation. These were the chief forms known to the Egyptians. Greece added the theater, the first secular public buildings, and the school or academy. But it remained for Rome, politically the greatest of ancient civilizations, to develop the vast variety of architectural tools—aqueducts, forums with their related systems of public buildings, baths, bridges, sewers, multiple-floored stores for merchandise, and law courts. Architecture furnished the means for the power and organization of Rome as truly as did her legions and her generals. Cathedrals, castles, and guild halls are tools of the church, the feudal lords, and the merchants of medieval life.

The progress of each period is marked by the architectural implements it evolves. Tools en-

able a people to develop more complicated social organization; they multiply the effectiveness of human activity. The man who lives in a hut can do but a fraction of the work that a house-dweller accomplishes. A city that has a town hall, has the means for efficient municipal organization.

In modern life, architecture has become a class name for a vast number of specialized tools. Our schools, museums, libraries, hospitals, factories, grain elevators, and apartment houses all differ very strikingly in appearance and function. Nearly all the institutions of modern society employ a specialized architectural implement. This architecture can be used efficiently for only one purpose. The lofty modern office building could not be converted into cliff dwellings without radical alterations; nor could so complex a tool as a great railway station or a theater be used for a department store or a research laboratory.

But in spite of its specialization, one function of architecture has remained constant through the ages. Buildings are tools for making climate. Through countless ages of exposure to heat and cold, sun and rain, wind and snow, man has never learned to adapt himself to the variations in climate. Always, from the time of the cave or brush hut, he has been trying to perfect a tool

that would enable him, at least in a restricted area, to regulate and control the weather.

To-day in modern architecture, man has a highly developed climatic instrument. Automatic heat control does not allow the temperature in our buildings to vary more than a few degrees summer and winter. Recently, cooling systems are combating the excessive temperatures of summer. Artificial light, more constant and better distributed than daylight, is readily available. Where daylight still is used, a new kind of glass admits the health-giving ultra-violet rays. Improved means of ventilation not only keep the air in circulation but filter it and regulate its humidity. As long as we stay indoors, we may have whatever weather suits our whim. We may freeze our food in one chamber and enjoy the heat of a Turkish bath in another. Thus we may dwell or work in the atmosphere in which we feel most productive, without the numbing effect of intense cold or the debilitating result of tropic heat. The tool by which we turn winter into perpetual summer is architecture.

Contemporary architecture differs from ancient in the astonishing amount of work which it performs mechanically. The modern building is a power machine that accomplishes simultaneously a variety of particular operations. In

addition to carrying on the old functions of heating and lighting, these buildings have elevators, plumbing with hot and cold water, mail and laundry chutes, fire extinguishers, power cleaners, incinerators, pneumatic tubes, telephones, telegraphs, radios. The old canons of architecture scarcely apply to a modern building. Instead of a static equipoise of stone, architecture has become a machine throbbing with energy and movement. It is a dynamic agency of the swiftly flowing current of human life. Ceasing to be a passive background, it is taking a more and more active rôle. No longer inert, it multiplies human vitality, endowing man with giant power.

This new dynamic architecture which has so augmented man's potentiality is a necessary tool of modern civilization. We distinguish one society as primitive and another as advanced by the size of the political and social units, and the degree to which individuals and groups are autonomous as far as their daily needs are concerned. According to these criteria, a civilized man is one capable of forming great nations, great cities, and great social, religious, and commercial organizations. Instead of being practically self-sufficient he is dependent directly or indirectly on thousands of others. How has this coöperative thing called civilized society been

brought about? By tools for transportation, by power machinery, by architecture. The skyscraper is the visible symbol of the great corporation, the insurance company with nation-wide representatives, the bank with investors from coast to coast. But it is more than a symbol in the abstract sense, for it is one of the necessary instruments for attaining and utilizing such organization.

Functionally speaking, no architecture has ever reached such perfection as that of modern America. Step into a great modern office building, that economic dynamo whirring with human power more potent than the mechanical energy of coal and oil. Read the list of businesses and professions that are housed within a single building. Here is a roster of human endeavor, —merchants, doctors, brokers, financiers, charities, publishers. The barber and the baker are there too. Here is a greater and more various population under one roof than existed in an entire city of ancient times. What is this immense mass of steel and brick? Is it not an instrument for a kind of socialism more mighty than any ever forged by Karl Marx or other Utopians?

Architecture is a tool by which man achieves social solidarity, by which he apportions and shares his labors. The building is the instrument

which makes possible our larger social groups.

Culture might be defined as the sum of the ways of acting and thinking which we have learned from the past. How is this culture of ours made from generation to generation? Why does it conform to a different mold than that of the African Negro, the Indian, or the Chinese? Externally the chief method by which culture is implanted is through tools. Important among these is architecture.

The American who spends his idle time in Europe often ponders about the difference in the culture which he encounters there, its greater individualism, its closer rapport with the past, its æsthetic quality which makes for the charm of life quite apart from its practical results. But what people would not sing opera airs as they floated past the palaces of tinted marble along the Grand Canal? How is it possible to stand in the arena of the Coliseum and not imagine the Rome of old? And London, modern city that it is with its new Regent street winding down to Piccadilly Circus, is full of side doors through which one may slip back two or three centuries or even a thousand years.

Architecture shapes culture in present as well as past molds. The modern building, however quaintly costumed in the picturesque or formal styles of old, has little patience with these ghosts

of the past. It exerts all its power to teach its occupants the modern doctrine of speed and success, of economics and science, of machinery and power. Even more impatient of the older architecture than man himself, the new overshadows it disdainfully unless curbed, and encourages ruthless wrecking of older edifices to make way for its progeny.

Mythology might linger in the vaulted chambers of the stout survivors of medieval times. But modern architecture is positivistic and skeptical. It knows that it must produce a return on the investment which it represents, and is ready to be demolished for newer structures as soon as it has become antiquated and unprofitable. These modern buildings entertain no sentimental views of immortality as did the architecture of old. Youth that enters their doors need have little schooling to catch the purport of the message. Poetry and romance here are out of place. If they linger, they must be disguised in terms that sound hard and practical.

Mechanical civilization is as much a matter of architecture as of the machine. In fact the two can hardly be distinguished except for purposes of casual speech. Our architecture is as much a super-machine as the multiple printing press, the transoceanic liner, the dirigible.

Architectural implements are makers of cul-

ture as potent in their way as books, schools, and governments. Too long buildings have been regarded simply as background for the stage of human affairs. With the coming of the psychologist, architecture is revealed as one of the most effective means of controlling human behavior. Buildings wall in man's thoughts and circumscribe his field of action as certainly as do laws and geographic barriers. The king is locked within his palace, the merchant is ruled by his store, and the householder serves his homestead as master.

The tool educates the society that employs it. Where a superior architectural instrument exists, it encourages men to great accomplishment. Awkward tools produce ignorant workmen. The tool becomes the tutor of its possessors. Their culture or civilization is not only carved out by them with whatever instruments they may have, but in the carving the workmen learn to enrich their experience and extend their powers.

Architecture shapes social institutions as well as shelters them. The Parthenon left its impress upon Greek life, the Coliseum upon the Romans, the cathedral stamped medieval thought, and the factory has left its trade mark upon our generation.

Architecture is both an instructor and a guardian of the race. Man rears the cathedral for

worship and the cathedral teaches him how to pray. The cathedral, not the changing creed, becomes the defender of a timeless faith, the perpetuator of the institution of the church.

The language of books is akin to daily speech and its influence on thought may readily be seen. But the language of buildings is in terms of space, color and light, line and resisting materials. How can these communicate ideas, how can such silent guardians manifest their commands? The psychologist might reply that this silent speech cries louder than words, that it is a stronger, more primitive form of communication than alphabets.

The potency of architectural linguistics is due to a power of their own augmented by a borrowed power of association. The child is never at ease in a school room in which he has been punished or derided. Employees returning to their factory after a strike feel the atmosphere of hatred and distrust in every familiar column and beam, so that fear and malice smolder on long after a settlement has been reached.

Perhaps the most amusing example of architectural conditioning is associated with the old-time New England best parlor. This room, intimately connected with funerals and formal weddings, was also reserved for entertaining strangers. One chilling visit to a family which in its

back parlor or hospitable kitchen betrayed no symptoms of New England austerity, but which stiffened to embarrassed silence in the seldom-entered front parlor, is enough to leave an indelible memory. The parlor was an instrument of rigid formality, not of sociability. It imposed its character upon its human occupants.

But architecture also operates in more potent ways. A summer of cycling about England helps to explain why the old aristocratic system has lingered there so long. The man in the cottage needs no other restraint than the whitewashed walls of his fireside. That small snug structure with its thatched roof and oaken half timbers constrains his mind to small snug thoughts. There are associations also which bind him as truly as they did his fathers in the ancient days of serfdom. Great or revolutionary ideas could only occur to a genius in such a "homely" place. Even Shakespeare could scarcely have written much that was great in the Stratford tavern shown as his birthplace or in the Anne Hathaway cottage.

The English nobleman was "supported," as actors say, by an imposing mansion. If history does not gossip maliciously, many of these aristocrats were very weak human clay indeed. They needed far more than the accident of birth to maintain their superior positions. Their dig-

nified and stately manors not only gave a bold front to their claims, but also invested the owners with borrowed power. Who can visit one of those old mansions for a single day without feeling imposed upon him something of the grand manner?

Architecture has always been one of the stanchest supporters of social systems, aristocratic or otherwise. Probably the supreme example of this may be seen in France. The great châteaux, particularly in the neighborhood of Tours, still exhibit the grand air of the French Monarchy. The Louvre and Versailles were instruments for creating a splendid court life; Chambord and Chenonceaux built the nobility.

As we think of the distinctive variations in western culture which the different nations of America and Europe represent, certain causes for these differences, such as race, climate, topography, and natural resources, at once occur to our minds. Architecture exhibits these differences surprisingly, considering that certain styles are so generally employed. Does this architectural divergence only express the other and more fundamental differences, or is it in turn one of the causes?

The more the mixture of race in every modern nation comes to be recognized the more it becomes patent that cultural differences are to a

large extent independent of race. Similarly while geographic conditions shape human conduct profoundly, culture often transcends very wide physical contrasts. Apparently these elaborate culture patterns are to a considerable extent man-made. In a given forest environment the savage may contrive his shelter and determine his taboos and rituals in an almost unlimited number of ways. He and not his environment decides the pattern.

But how are these patterns fixed? Why is it so hard for a people to change its customs? Religion, education, occupation, objects of art—and architecture more than the other arts because of its universality—all play their part in transmitting the ritual of a given civilization.

How does Americanization take place? Not by treating a uniform race to a uniform climate. Not wholly by education, labor, and social contact. Partly, at least, by living in American buildings with their superior plumbing, lighting, and heating and their unimaginative design. Put any people in these architectural molds and they will take on the characteristics of America, as so many have. The place where Americanization progresses slowly is in the obsolete slum which lacks the advantages of democracy—a high standard of living and physical comfort.

As one ponders on architecture as a mechani-

cal tool for doing a certain piece of work, admiration for its achievements is tempered by certain doubts. How well does it perform its functions? And are these functions, everything considered, those man wishes to have performed?

The first tools with which man sought to increase his powers required a maximum of human effort for operation. Man toiled to guide the handle of his plow only less arduously than did his oxen to drag the plow. With the modern tool mechanical power performs the work formerly done by human muscle. But architecture today still demands a disproportionate amount of man-power. Boilers, elevators, windows, doors, all must be tended or operated by human labor. The ideal tool is silent and automatic in its work, requiring only occasional supervision. The distant hydro-electric plant directed by engineers miles away is an example. The force of men which a modern building requires is testimony that these tools are still archaic, still extravagant of human labor.

From a medical standpoint the specifications for a healthy human environment may readily be sketched with little variation in opinion. A doctor might define architecture functionally as a tool for creating an artificial environment more sanitary and invigorating than the rather crude and harsh hospitality which nature affords.

In most climates architecture probably meets the bare requirements of this minimum definition. But were we to ask whether the architectural tool enabled us to attain the maximum health and efficiency of which our rather fragile organisms are capable, no one but a realtor (a being not included in the Oxford dictionary) would maintain the affirmative.

Nor does one have to point to the tenement districts in our cities alone. Many of our new buildings are poorly ventilated, glaringly lighted, overheated, overcrowded, lacking in privacy, noisy, bacteria laden. To be sure, they probably represent a modest improvement on the past. But are they tools for producing and maintaining health? Or do they on the whole tend to undermine it? About the best that can be said for modern architecture on this score is that it is at present rapidly growing better. A few examples have already proved that buildings can be made more healthful places in which to live and work.

But most tools of stone and wood and steel are far from being health builders. They are still clumsy instruments for performing this task. Yet socially this function is in the long run as important as any economic consideration. The air in a majority of our theaters during the last act is much the same quality as that of the black hole of Calcutta. The air in our offices is

constantly heavy with dust. One may write with his finger on a blank piece of paper left on a desk overnight. In a metropolitan hotel it is useless to try to sleep before the street and internal sounds begin to die down toward midnight. Such facts do not lead to eulogies of modern architecture as a tool for physical well-being.

Nor can the blame be placed only on the shoulders of the architect. For he and the engineer have demonstrated in certain modern buildings, where they have been granted the opportunity, that these conditions, so menacing to public health, can be largely overcome. The public itself is too prone to save a few dollars in construction and put up with unsanitary buildings. This blood money is costly in the end. Few outside the medical profession are aware of the price because it is exacted indirectly.

But man does not grow ill by bacteria, lack of air, and noise alone. Ugliness is full of toxic poison which destroys the imagination. Our cities, especially in America, are crowded with grim structures debasing to taste and depressing to the eye. Most of these buildings can claim no legitimate architect-parent. They are the offspring of commercialism.

Thrill at the gracefully curved lines of a motor boat as it speeds through the green water, or notice the clean unbroken contours of a modern

engine, and it becomes apparent that even mechanical things may attain beauty of the highest order. Now and then an artist-architect has the opportunity of showing that a factory or a warehouse may be humanized, may be given strong vigorous form that delights the eye. Quite apart from their æsthetic appeal such tools are better instruments for human use than stark, repellent ones.

The armorer of old knew well that when he wrought a curious device in the handle of the knight's sword, he added an invisible might to his arm. Buildings with lines that are in repose, with designs that are free and vital, lend their power to those who use them. The beholder feels at ease and goes his way well satisfied. This is the kind of health and well-being that the artist and poet bring, a contribution quite as important as that of the doctor. The tool that lacks this subtle grace is but poorly fitted for human use, no matter how keen its edge.

Our instruments to-day are the work of applied science. And science itself places high store on imagination. It might be truthfully called a form of adult imagination in contrast to the child's, which deals with fairies and fables. Scientific discovery and invention demand a trained imagination, senses keenly alert. The social function of art is precisely to keep the senses from

growing stale and the inventiveness of the mind from being starved by narrow routine.

Supposing architectural tools were perfected into structures of efficiency and beauty—would we ultimately be satisfied with the functions that they now perform? To-day most of our great buildings are commercial in character. Should we regard this economic life that absorbs so much of our vitality as an end or as a means? Is it necessary always to expend most of our energy in trafficking and promoting and exploiting, or should we prefer tools that also lend themselves to social life, æsthetic enjoyment, and recreation? Do we want tools that will help us to live as well as to toil?

For answer the architect tool-maker must turn to the philosopher and ask him to define the good life. He must question the psychologist and the doctor, those modern inheritors of the priest and the medicine man of old, and ask what kind of an artificial world is most suited to man's happiness and well-being. The architect will invent cunning instruments provided he knows what work they are to perform. At present he is asked mainly to build structures that will yield an economic return and this task he has accomplished. Occasionally in a model housing development, a public building, a school,

or a library, the architect exhibits vision that looks beyond gain and income and rentals.

From the functional point of view, what is good architecture? What is a superior tool? The definition can no longer be couched in narrow terms. It must be formulated with reference to the worker as well as to the work performed. It must have an eye to the ultimate task as well as the immediate work done.

The superior tool will perform a given piece of work excellently well. It is an airy theater in which every seat commands a fair view of the stage and the ear may hear the actor's least inflection; or it is a great factory in which the many acres of floor space all are laid out to feed efficiently into a main assembly line. And it goes without saying that in this day and age the tool must be highly specialized, a point more often remembered in commercial and industrial buildings than in public ones.

The tool should be an instrument of health and general social well-being. Toil is a means by which men increase their power when the tools they wield are designed to their use. Society may well look to her buildings and broad cities and inquire whether these instruments are protecting her human resources, whether they are wasting or utilizing to the full this human power. The human cost of inferior architecture

is appalling and it lays its burden on all, both those who must live or toil in such surroundings and those who pay for this waste indirectly. The best type of tool teaches the worker who employs it. It draws upon his skill, touches his pride of craftsmanship and keeps alive within him his vital spark of imagination.

For human beings the tool must be æsthetically beautiful, or its edge is blunt indeed. Man responds quickly to his architectural environment. He will do his best work with the room tool that delights his eye as well as suits his needs. The dingy factory makes the stooped and benumbed workman, the studio creates the artist, the study educates the scholar. To be practical the tool must be beautiful.

How may architecture be planned as a tool for the general social good? Not by considering individual buildings as the architect is usually forced to do in drawing his plans. For works of architecture do not stand alone. Buildings are used in groups, as vast batteries of tools. Unless these are carefully coördinated they are not only wasteful but actually impede social processes. The great fault of the modern city, functionally speaking, is that it is largely a fortuitous assemblage of poorly integrated units. The results of trusting to chance instead of exercising control over the city's growth are traffic congestion,

rapid depreciation and obsolescence of buildings, crowded housing conditions, and restricted business and industry.

City planning is a great step in advance over building planning. It replaces development for private interests by development for public interest. It outlines a general city plan according to which the architect may bring his individual building plan into effective relation to other structures. It provides ample space for attractive housing, for efficient business, for accessible manufacture, for serviceable public buildings, for parks and recreation. City planning is a way of using scientific method for social control.

Ultimately a new type of architect is needed, one engaged not in planning buildings, cities, or even regions, but one who plans states and nations. At present "state architects" have charge of the design of public buildings erected by the state. The new planner of states and nations will not be occupied with public buildings. His task will be to correlate cities, rural communities, parks and camping grounds, water power, highways, waterways, transportation, terminal facilities, all into a super-plan for common weal. Regional planning points toward state and national planning.

To gain a broad view of architecture as a tool, we must recall that it is one means of creating

civilization. In planning buildings we are not only devising structures of brick and stone, but we are determining the patterns of organized existence. The function of architecture is to provide social tools, the use of which will promote well-being and increase knowledge.

IV

SOLID GEOMETRY

Structure

ARCHITECTURAL solids exhibit concretely all the host of theoretic shapes and planes dealt with abstractly by geometry. Architectural engineering may be legitimately described—in an essay at least—as a branch of solid geometry, notwithstanding the fact that architecture is not solid in the literal sense and engineering uses less solid than plane geometry and less geometry than other mathematics. The geometrician is interested in the mathematical relationships of three-dimensional forms and so is the engineer. The main difference is that the former occupies his mind with Platonic ideas that have no space-time existence whatever, whereas the latter is a materialist dealing with extremely tangible data.

To be interested in both the concrete and the abstract is to be a scientist. There is ground for believing that science was born under the hospitable roof of architecture. Research seems to indicate that the Greek temple was a result of science as well as of religion. Its whole design appears to have been under strict geometric control. The development from the earlier forms

to the perfected type of the Parthenon illustrates the growth of a true experimental method.

Architecture as the birthplace of science has a peculiar significance. For if it is not bad form to relate a myth about the birth of science as did the wise Diotima in recounting the origin of love to Socrates, the parentage of science goes far to explain its dual and conflicting nature. Historical gossip has it that one parent of science was an artisan who toiled ingeniously while the other was a profound philosopher given to mathematical speculation. This oddly contrasted pair were brought together by architecture. The respective genders of the two parents remain obscure in this doubtful tale. Yet the suspicion that the blood of the mechanic and mathematician both are there is of long standing and is circumstantially supported by early records.

How these two parents succeeded in breaking down the rigid class barriers that in the ancient world separated the slave from the freeman and dared a marriage that was in the modern sense democratic would be a mystery were it not for architecture. No doubt the toiler was a mason engaged on some building of public importance. The problem of laying out and superintending so complicated a structure would naturally be assigned to a thinker, a philosopher or mathematician. Among the unhewn stones newly brought

to the site, the two so different in breeding and outlook met over the common difficulties that inevitably surround an architectural commission.

As every builder knows, the first task before erecting a new building is to square the corners. If you watch a master mason do this to-day, you will witness an example of mathematical thinking that goes back at least as far as 1700 B.C., as is attested by Egyptian papyri. The corner is found from a right triangle which is constructed by means of two taut cords stretched from stakes driven into the earth. From the intersection of these cords, equal units are carefully measured, three for one side and four for the other. If the hypotenuse is made to equal five, the two sides are exactly at right angles. When the units are short, the numbers six, eight, and ten may be chosen for greater accuracy. In some such practice as this the science of architecture, which was in the beginning the only real science, originated. No doubt the astute philosopher suggested the practice and the artisan carefully verified the truth of his hypothesis by trying it.

The association deepened into a firmer union as the two worked out other problems. There were difficult questions of division in spacing columns. The columns themselves called for more than the mason's knowledge of circles and

their mysterious properties. Exact measurements, on the other hand, could only be made by the worker accustomed to the precise use of tools. One of the two thought of using the plumb line for keeping the walls vertical. Horizontal lines may have at first been laboriously worked out from the plumb line by right triangles, or more likely the ingenious artisan taught the philosopher an easier way of establishing them by sighting across a trough of water filled to the brim at both ends. The exact steps in solving these problems are somewhat obscure at this date, but we know, from the square, true buildings that have survived, that in very early times men contrived to master them.

Thus architecture developed the first method of dealing with the physical world in accurate mathematical ways. In the process of achieving this great advance, it discovered geometry, the first great tool of science. After these basic discoveries it was only a matter of time before other men besides builders and architects learned to think and work accurately.

The historical fact that wherever an accurate architecture developed—as in Egypt, Babylonia, and Greece—there, too, mathematics made progress, is more than a coincidence. Architecture set the problems and furnished a laboratory where they could be solved. When the method

was once learned it was readily applied to land survey, and to astronomy and to more abstract speculation. As the philosopher discovered the universal nature of mathematics he became so much interested in its logical problems that he forgot its very concrete and practical origin. This is still traceable, however, in many of his habits of thought and in the words which he used. Plato and the Pythagoreans always thought of numbers in a figure of some sort. The gnomen or carpenter's square became a common mathematical term.

This brief historical background pieced out by a genealogical myth points to the close relationship which architecture has always borne to geometry and mathematics. While this is obvious to any draftsman or architect, the layman and critic have usually been aware only of the practical or æsthetic aspects of the art. The drafting-room is a training school for geometricians even where the emphasis is largely on artistic design and a maximum of freehand work is done. All the questions of scale, proportion, and division, as well as the more complicated problems of graphics, projections, perspective, shadows, and stereotomy or stone joining, lead to geometric analysis of the most intricate sort. Many structural problems, such as finding the

stresses in a truss, are also readily solved graphically.

In the modern world the science of architecture has been revolutionized by an extension of the early mathematical method called engineering. Though from the first a mathematical thinker, the architect did not realize until very recently that all his structural and mechanical problems could be handled mathematically. For centuries he was content to use his early scientific discoveries without expanding them. The sudden discovery that mathematics, based, of course, on systematic experimentation and supplemented by testing, would enable him to predict and control the structural stresses and the strength of materials, has brought about an advance that sharply distinguishes modern architecture from that of the past. To-day architecture is an exact science. That of the past was a very primitive science supplemented by rules of thumb and current practice.

The contemporary renaissance of architecture is not primarily due to new materials, to more creative designing, or to social needs, important as all these are. It is due rather to the fact that architecture has become a full-fledged science. Vagaries and guesswork are eliminated, or very nearly so. This new, exact way of thinking is the force behind the new spirit in architecture,

and the key to its modernism. If artistic design flourishes with fresh vitality, the stimulus for this flowering is science.

Why architecture, which led the way in science, should have rested content with small advances from classic times to the present before making full use of the scientific method, may be partly due to its reverence for the past—that form of ancestor worship so ingrained in western culture. Like theology and law, architecture has looked backward for its guidance and committed all the follies of classicism. But this conservatism is more a human characteristic than an architectural one.

An architecture that could achieve the medieval cathedral or the domes of the renaissance without figuring stresses exactly had no need for exerting itself further. As is ever the case, its virtuosity was the enemy of its further achievement.

The developed structural science of engineering which is the fundamental differentia of modern architecture is the cause of two more obvious differences, those of materials and workmanship. Steel is eulogized as the great discovery of the modern builders. Of all the long list of new building materials invented by the last few generations, steel, the magic ladder that gives architecture access to the sky, is the mightiest. But

steel is itself a product of science, a material requiring an intricate industrial technique for its manufacture and specialized knowledge for its structural use. Iron had long been employed by the builder but not until science developed it into steel did it become an important structural material. Many old materials such as concrete and terra cotta have been rediscovered or improved. The Romans used concrete extensively. Terra cotta was employed by the Babylonians. What is new is not so much the materials as our new knowledge of them and control over them.

The second new factor, also a result of science, is the replacement of the workman by the machine. The laborer no longer autographs his work with his hand tool. Modern buildings bear the signature of the machine. Our materials come to the building site already highly manufactured. The workman only puts them together. Whereas formerly he was a craftsman, who could by his own skill turn raw materials into finished form for construction, to-day he is an assembler who combines finished products, prepared by machine labor.

In Gothic times each trade produced its own materials, shaped them for use, put them into place and ornamented them. Our academicians, steeped in the reverential study of buildings of the handicraft period, look upon the machine-

made product of science with horror. They protest against the decay of architecture as an art, though actually they are not so much concerned with the decay of art as the defense of an old craft. The painter of the future may conceivably discard the bristle brush and canvas and spray his pigments on sheets of metal. The excellence of the painting, however, will depend chiefly on the artist himself and only incidentally on his mechanical or manual technique.

Only a sketch of the new science of architecture is possible without recourse to formulæ and equations, those lustrous bits of universal truth so distasteful to the men of this age of fable. But an outline may suffice to show how clear and beautiful is the logic of the new architecture which replaces the lore and legend of the old. Take two descriptions in a recent booklet on the Cathedral of St. John the Divine, now in process of construction in New York. The first says: "When the student, who has familiarized himself with the medieval cathedrals, first enters the nave of St. John's, looks through the two lines of soaring columns that sweep, unbroken, from floor to roof, and appreciates the vast stretch from clerestory window to clerestory window, he will realize that here is something which, for sheer majesty of effect, is unmatched among the ca-

thedrals of the world." The second says: "Area 109,082 sq. ft., height 400 ft., interior height 124 ft., exterior length 601 ft., width of central aisle 56 ft." Both of these descriptions are effectively expressed. The first, ironically enough, is by a well known scientific writer. It presents a somewhat vague but impressive picture of the cathedral and suggests the emotion that its grandeur will inspire in the beholder. But it is lacking in facts, and for practical purposes is quite meaningless. The second description is compact, clear, and stuffed with serviceable data. In the first case we have the language of literature; in the second, that of engineering.

The first principle of engineering is to express all, or as much as possible of its data—area, pressure per square inch, load in pounds, or dimensions—in numerical terms. This gives an exact quantitative description, not very inspiring to the imagination, but precise and definite. The process of translating the data into numerical form is also a filtering method which separates the knowledge sought by the engineer from the myriad of irrelevances in which it is imbedded. When all these divergent data are once put in figures, they have actually been reduced to a common language, so, in spite of divergences, all may be handled in the same way. Mathematics, then, is a way of ordering up an untidy situa-

tion, and arranging it so that all of its relationships may easily be analyzed.

One of the simplest of all structural problems is that of the post and lintel. Egyptian and Greek architecture are spoken of as trabeated, a style in which the beam resting on posts or walls forms the chief constructive feature. The problem of the lintel is one that nearly any of us may be called upon to solve, so that it is well to have some idea as to the methods of engineering in dealing with it.

The analysis must begin with social function. Is this post and lintel combination to be a gate, a door, part of a lower and an upper story, or what? If a gate, how determine the width? The width of the Propylæa or entrance to the Acropolis at Athens is supposed to have been determined by the breadth of the chariots which were driven through, although this meant that the central columns had to be spaced 12 feet 4 inches apart whereas the other four were only 6 feet apart.

The second major problem involved in the lintel is that of materials. Shall we build of wood, stone, concrete, brick, or steel? At once the persistent economic factor presents itself. Statistics are readily available for these various classes of construction, for both first cost and depreciation.

But the question of materials appears to be

more complex than mere economics. Take wood for example. Though inexpensive it is listed as an extremely perishable material with a probable life of perhaps a score of years. One recalls the venerable half-timbered houses of Brittany leaning stanchly on their oaken timbers and crotchets. Surely the service of wood such as this is to be measured in receding centuries, not years. Or in prying about New York, one happens on the fact that the oldest wood known on the island of Manhattan is some sticks of alder excavated from a depth that shows they are 20,000 years old and have lasted since the Pleistocene glacial age. These sticks look fresh, as though they could be whittled or split like any contemporary alder.

Here we have hit on a weakness of mathematical formulation. Mathematics deals with averages or minimums, disregarding the wide range of variation in individual cases. To be sure, a more detailed classification will help to meet this difficulty but it will never quite eliminate it. That is, we know that such woods as cedar, cypress, redwood, chestnut, and the best oak, may be classed as extremely durable, while cottonwood, maple, elm, beech, birch, and sycamore are short-lived. But some further qualification seems to be needed. If subjected to wear, the soft coarse-grained cypress or redwood very soon

splinters away, while if protected from exposure the fine hard grain of maple and beech last well. The durability of a given material depends much on how it is used. In addition to mathematical accounts, detailed descriptions of practical physical qualities are necessary.

Naturally we are also interested in the strength of various materials. This depends partly on their reliability. If statistics show that wood of various trees and various grades differs very widely we must be on our guard and make wood members oversize. Factors of safety as high as ten are commonly used for wood. In other words, structures of wood are often made ten times as strong as is found necessary by actual test for the best quality of lumber. Steel on the other hand is very uniform and reliable as it is now manufactured, so that in common practice a factor of safety of four or less is ample to allow for defects or unforeseen elements. A material will also vary with age. Concrete a year old is about fifty per cent stronger than concrete thirty days old on the basis of which working stresses are usually figured. As to actual differences in strength, working stresses in compression for steel are as high as 16,000 pounds per square inch; for wood, 1,500 pounds, and for concrete 650 pounds as a maximum. That is to

say, wood is three times as strong as concrete, and steel ten times as strong as wood.

But to return to the lintel. Its structural aspect opens up a whole Pandora's box of mathematical terminology, bending moments, shear, deflection, section moduli, and their accompanying formulæ. The example of Pandora's sufferings must be a warning to keep the lid tightly closed and only hint darkly as to the probable contents of the box.

The nature of the beam may be illustrated by two closed books held together end to end with covers vertical, backs down, and leaf edges up. If these are grasped or supported at opposite ends and a load is placed on them, their leaves will tend to telescope together at the top and their backs will tend to be moved apart at the bottom. In other words, one might consider the top edge of the beam as a column laid on its side taking compression; and the lower edge as a cable stretched parallel to the column taking tension. The part in between column and cable simply serves as a web to hold them together.

For each kind of load that can be placed on a beam, the engineer has his formula for the bending moment. The one for a beam loaded uniformly from end to end is Wl/8. "W" stands for the weight or uniform load and "l" for the length of the beam. Had the beam borne a con-

centrated load at its center its formula would have been Wl/4. The engineer's tool kit is full of these formulæ which are as useful to him as his slide rule. Wl/8 is a shorthand note of the universal law. It is an epitome of cosmic order. Spinoza, had he been aware of its existence, would have regarded it as guide to the intellectual love of God. It tells the secret of one of those mysteries which the poet of the flower in the crannied wall sought to divine. It is an ethical standard by which inanimate members the world over scrupulously regulate their conduct.

Each time the engineer uses the formula, Wl/8 he reasserts his belief that nature is uniform and unvarying. Here we have the scientist able to predict the behavior of any particular beam because he knows the universal law of beams. This prophetic power has replaced the ignorant practice of following precedents, of designing beams like other beams which had served in the past. Science has swept aside all this enslavement to the past and bound the future to man's service.

No beam that the builder requires offers any novel or unknown situations. Always there is a formula that may be applied. All that is required is that he know the situation and the law which is pertinent. The scientist has classified a frequently recurring relation and analyzed its

nature. From henceforward he is master in all such circumstances. Materials may differ and so many times and places but the formula is changeless.

Other aspects of the formula besides its universality merit consideration. Formulæ may be rational or empirical. Wl/8 is rational because it may be reasoned out mathematically from a consistent theory of moments. Other formulæ, such, for example, as those used for columns, are either only partially rational or wholly empirical. Euler's formula for columns is only partially rational because it is based on imaginary assumptions. The so-called straight-line formula is the one most widely used for columns and is wholly empirical. It has the advantage of greater simplicity. This formula keeps the column stresses for working lengths within the limits which tests have shown are safe, but these empirical formulæ have no rational or theoretic basis. They summarize past experience but cannot be called universal laws because they are not logically related to the known body of physical theory.

The practice of engineering rests on the two types of data, rational and empirical. A truss may be considered an assembly of triangles, the only polygon, which, if constructed of rigid members hinged together at the joints, cannot be distorted. It is a simple matter of trigonom-

etry or graphics to compute the stresses of an ordinary truss, once the loads are known. Either of these methods can be explained in terms of mathematical principles. A given solution can also be verified experimentally. But in the case of empirical formulæ the engineer is following the results of tests blindly, without knowing why.

Mechanical equipment offers as many opportunities as does structure for the use of formulæ. How much water will a given size of pipe convey at a given pressure? How many people will an elevator of given size handle? How large should electric wires be? How many square feet of radiator surface are required for a particular room? These are all questions that the builder of former times, had he had occasion to ask them, would have had to answer by a trial and error procedure. To-day this element of judgment, this human factor, though not wholly eliminated, is reduced to a very small percentage. Mechanical design is a science operating with a high degree of certainty. Gothic architecture with its nice balance of thrusts and counter thrusts, its concentration of forces on narrow piers, is from the engineering point of view the highest achievement of the later Stone Age in architecture. But its triumphs did not rest on a rational analysis. The builders blindly fol-

lowed precedent or rashly adventured, and many a fallen central tower or buttress attests the cost of their bold experimentation. Engineering has eliminated this fortuitous character of architecture and made its plans authoritative assertions of what can be built with safety.

The development of engineering raises the question of the relation of structural design to architectural design. Is the engineer supplanting the architect? Is structure the dominant feature of architecture?

From about the time of the renaissance the architect and the builder have each had separate tasks. Each generation has seen the work of the builder divided among more and more trades, each with its own skills and materials. The direction of these trades has come into the hands of business men called contractors and subcontractors. But the architect continued to have charge of all the design, though it is a good many years in most countries since he was a bona fide builder or since he exercised the practical functions of the modern contractor.

The coming of the engineer has now relieved the architect of a large part of the work of structural and mechanical design. Does this mean that the architect will soon be as extinct a species as the armored knight, the courtier, or the cowboy? A superficial observation might

interpret the metamorphosis of the architect from the position of master-builder in the pre-renaissance guild system to the rôle of a designer or "mere draftsman" as a sign of this decadence.

What is actually happening is that the complicated tasks of planning and erecting buildings are being divided up among more and more specialists. Instead of being a jack-of-all-trades, and a bit of an engineer and of a designer to boot, the architect has now concentrated on one profession. He plays two essential rôles in the modern drama of steel and power. The architect's practical function is that of general. He must correlate the diverse tasks of others and direct them toward a unified structure. The architect's other task is that of artist. He must create beauty from steel and power. Without denying the brute strength of the raw materials and the grim utilitarian demands, he must design buildings friendly to the eye and mind of man.

The relation of structure to architecture is a more puzzling question. It is sometimes said that structure is the soul of architecture. This assertion constrains one to suspect that at least as far as architecture is concerned, the soul is a myth. Is the Parthenon but the supreme outworking of the principle of the post and lintel? And buildings of the renaissance—proverbially reticent about their internal structure—are they

the flower of the union of round arch and column? Whatever the subtle relation of architectural design to structure, the two are hardly to be identified without thoughtful consideration.

From a strictly engineering angle, gas tanks, those mammoth drums of steel constructed with astonishing economy and efficiency of materials, considering their imposing size, must be regarded as thoroughly commendable monuments of modern design. The elevated railway, though now a little antiquated, in its day possessed merits of a high degree. One thinks also of the fireproof warehouse, the factory of concrete, the ramp garage, and those many other efficiently designed progeny of the engineer.

All of these structures exhibit to the trained eye both skill and ingenuity in serving the purposes for which they are designated. Occasionally, too, the engineer forgets his formulæ and cost sheet long enough to add a line or form of effective beauty. But this is a personal whim, not a professional interest.

The tendency to identify structure with æsthetic design arises from a genetic fallacy—explaining a developed phenomenon in terms of its origin. The Greek temple still bears the birth marks of its timbered prototype. But its highly refined proportions and patterned system, though

developed from this primitive structure, can hardly be said to be caused or explained by it. Greek imagination, as clear and poised in its line-space conceptions as in its logic and its literature, gave the temple the touch of life. The line of evolution proves the inadequacy of mere structure, not its dominance.

Leaving æsthetic consideration aside, is it possible to define beauty in purely engineering terms? Firstly, a building would possess structural beauty if its design displayed mathematical order or system. Its structure would be clear, commensurate, and readily grasped in numbers or geometric figures. Secondly, it would utilize materials so as both to take advantage of all of their potential strength and endurance, and to compensate for any weakness they might have. This would involve a complete physical analysis and test for these various materials. Thirdly, it would be an efficient social instrument. It would fulfill its function adequately and completely. And fourthly, it would be economical in construction and operation. A building that possesses these four attributes is beautiful in the engineering sense, at least, whatever its æsthetic shortcomings.

Possibly a fifth quality should be added. The engineer is interested in scientific creation. He is striving to originate order in a chaotic world, to bend stubborn materials to his will, to conquer

situations in which the brute forces of nature attempt to defy him. This seems to be the artistic aspect of engineering. One must surely grant that the engineer's invention of laws for controlling materials, together with his instinct for order, however mechanical this may be at times, are both æsthetic. His work differs from that of the artist only in being employed for more practical purposes and in regulating imagination more rigorously to conform to mathematical rules. In short, here is scientific imagination in place of poetic imagination. The engineer's imagination is at work and the architect's is at play.

The splendor of the artist's dream blinds the student of architecture to the practical imagination of the engineer. This comes out whenever he applies a formula. No two situations are ever exactly alike. The scientist may insist on the thesis that nature is uniform but the antithesis that nature never repeats itself is equally true. How then is it ever possible to apply the universal principle to the concrete situation? Only by imagination of a high order. The gap, often a very large one, between the mathematical relationship and the particular problem, cannot be bridged by reason. Whatever the ultimate nature of the world, its more material aspects always stubbornly resist the

forms of reason. No rational situation ever exists in nature. The engineer must imagine the application of the formula and by a special act of creation make it fit. Our world is not a mechanistic one but must be made so.

Very often, too, the engineer faces an exploration task. In more complicated structures he must work out his own formulæ, discover some rational way of looking at a tangle of stresses and forces which no one has ever encountered or classified. Here engineering imagination with its keen mathematical tools shows to its best advantage. Mathematics is the great instrument of imagination because it issues laws which direct but do not restrict, it sets the path but points to limitless vistas. It beckons the swift flight of thought on to ever accelerating speed. Here engineering merges into pure science. Practical cares begin to drop away and the explorer presses on untrammeled. This original research is as rare as its name is common. It calls for ability that is akin to genius.

The application of engineering to architectural problems has revolutionized both the practice and theory of building. As is usual when there has been a radical change in thought, a good many accepted beliefs become obsolete. The persistence of these outworn notions has caused a vast amount of confusion and misunderstand-

ing in judging architecture. For example, one often hears the assertion that good architecture consists in "honest building." The word "honest" has a flavor more of ethics than of science and art. What is "honest building"? Is it the work of honest architects or engineers or contractors or workmen; or does it involve collective honesty on the part of all these parties? Or does the word "honest" apply in some way to the structure itself, to the ethical conduct of this inanimate object of steel and stone? A dishonest building might be one that settled and cracked; that willfully disobeyed the building code; or that, disregarding the well known principles of statics, failed utterly to stand up. This would seem the lowest moral depth to which a building could sink!

But in spite of ambiguity, the phrase "honest building" seems to have a meaning. It refers to a belief that the structure of a building should be frankly expressed in the exterior design. A building should not deceive the observer regarding its inner anatomy. According to this principle the modern screen wall carried on a hidden steel frame is dishonest. But building codes and moral codes, though grudging in their concessions, do in course of time accommodate themselves to human needs. They turn out to be very human institutions in spite of their pre-

tentious claims to divine origin. Time was when all forms of interest were unlawful usury. Similarly, certain codes grew up for stone or masonry structure, which no longer apply. To-day we use stone not only as a bearing material but quite as frequently as a facing material. Bearing walls of stone need wide even beds and must be well bonded if they are to carry a maximum weight. But a four-inch veneer of stone secured to a brick backing and supported on steel makes a durable and economical exterior surface.

Is this practice dishonest? Would it be more honest to express the steel? One greatly doubts the honesty of expressing steel if this means using it without the precaution of masonry fireproofing and protection from corrosion. The fact of the matter is that here is a new use of masonry quite as honest as the old one in which masonry took most of the structural stresses.

Honest building in the engineering sense means simply construction that will carry its loads without danger, that will endure economically for the time intended, that will fulfill its function efficiently. The workmen and contractor or even the engineer and architect may be scoundrels in their private life, but provided they accomplish such a building the job is honest. To insist on solid walls of cut stone or face brick would be uneconomical and prodigal. In a pub-

lic building likely to be of continuous use to the community, the architect and engineer are warranted in using the best materials. But even in structures of this type, there are few indeed which will not be obsolete within the century in this fast changing world. To build for all eternity but increases the wrecking bills of a few generations hence! The engineer is content to build for the probable period of a structure's usefulness and this he does, usually allowing a generous extra half century or so for possible extension of service.

In the last analysis the expression of structure, from the engineering aspect, is a matter of economy and simplicity. As a mathematician or geometrician the engineer desires an orderly unbroken exterior for his structure. He calls this giving it "clean" lines. He has nothing to hide, but he often does have extremely complicated framework and equipment, to exhibit all of which would be most confusing. A good design will naturally conceal a deal of this, though to ignore the structure completely would involve an extravagant outlay. No one has ever insisted that automobile manufacturers remove the cowls of their machines and display the mechanism, or that they expose more of the chassis.

The engineer is actually a stronger advocate

of honest building than any one else. What he objects to is archaic criticism. He has a difficult enough task to live up to the building codes of to-day. To insist that his work shall conform to the codes of the later Stone Age in architecture is to deny that this is a changing world.

V

STILL PASSION

Materials

THE early Greek philosophers believed that matter was alive. This doctrine is called hylozoism. It is a view held by many of the profoundest Greek thinkers. Even Aristotle accepted it in a somewhat modified form.

This ancient doctrine has always been a fundamental part of the artist's creed. Possibly when he uses the phrase "still life" the artist is simply echoing this inner belief that matter is alive.

To some degree, the modern scientific conception of matter tends to bear out hylozoism. Matter is never amorphous, never without internal structure. The chemical scientist pictures it as a seething mass of molecules constantly in motion. The physicist goes further and points out that each of these molecules is a system of atoms and that these atoms are made of tiny centers of energy called electrons. Examined under a high-powered microscope, matter exhibits a variety of crystalline and cellular structure that is well nigh inexhaustible. Matter is an infinite series of moving patterns.

The difference between what we loosely call living organic matter and lifeless inorganic matter turns out to be in the last analysis a difficult if not arbitrary distinction. All matter is active. None of it is internally formless. It appears on study to be most like an artist's design, a vast group of general patterns, endlessly repeated, with forever new variations. Indeed one wonders whether the human artist ever does anything but point out the richly patterned web of nature.

Every material which the artist touches responds according to an assertive character of its own. Woods are grainy, metals usually malleable, terra cotta brittle and vitreous. Clay yields sleekly to the fingers while marble must be bitten flake by flake with the hard edge of the chisel. The artist studies his materials as the poet does his words to bring out the rich range of qualities which they possess.

Each material is an opportunity and a limitation. The stone cannot be spun into lacework nor the metal carved. As the artist explores the possibilities of his medium his imagination is kindled. As he senses the restrictions which it imposes he is impelled to work according to law. Thus he achieves the controlled imagination which is the essence of art. He learns this secret from the materials with which he works.

Some materials have a very wide range of adaptability. They are versatile and impose only the slightest limits on the scope of the artist. With others, to give them appropriate form at all, is a *tour de force.*

Primitive art, especially in architecture, records an epic struggle between the will of the artist and the stubborn nature of the materials he seeks to subdue. As the artist's knowledge and technique increase, this dramatic contest of creator and that which is to be created becomes subordinate, though it never completely disappears from art. Very frequently the architect, in order to make his building more dramatic, will impose a difficult task on a stubborn old material, such as granite or limestone, which he might accomplish with far greater ease by employing more servile concrete or brick. The structure stands a silent monument to the conquest of its designer over strongly resistant materials and the whole design acquires an augmented strength.

The artist respects the individuality of his materials; he makes allowances for their idiosyncrasies; he develops their potentialities; he brings out their excellences and avoids their defects. He is a hylozoist, for he reverences the vital quality which brick and stone take on when given form and imaginative expression. The touch of the

tool may of necessity be stern and masterful but always there is the trace of a feminine caress about it.

From the broad range of qualities which materials offer, the architect as artist selects an entirely different group from the engineer. From the artistic aspect the important qualities are color, texture, light refraction, form, size, and those other features learned by long experience, such as workableness, strength, endurance, association, weight, weathering and aging, and gracious wearing. Of the first group of qualities the eye and finger are the judges, unaided by accurate mechanical devices. Memory and current folk belief, however mythological, are sufficient for the rest. The artist is careless of the engineer's precise measurements and tests.

The artist judges his materials partly by his eye and partly by the established character which they have taken on in their long intimate association with man. Oak, for example, has a venerable and aristocratic reputation that one would never suspect from simply looking over the engineering data on its physical properties. It has gained this character from serving as the ribs of ships on all the seven seas, from framing houses stanchly, from furniture and tools polished by long handling, from richly carved choir stalls.

This traditional reputation, together with its vigorous grain, nut brown color, and nobility that never becomes shoddy even when subjected to excessive wear, are the features which the artist values. To some extent artist and engineer are agreed on the durability of the material, but durability as an idea counts more with the artist than the fact.

As he scrutinizes a column the designer comments on whether it looks right—whether it seems too meager for the spreading vault above it, or too stocky and ground bound. His eye delights in seeing the column of heavy stone made to soar like a living tree.

The sober engineer, however, takes his tape and measures the circumference of the shaft. It is too small if the pressure of the load which it bears exceeds the amount prescribed by his formula for that type of column. It is too large if stone has been wasted so that there is more than is needful to shoulder the load.

Both artist and engineer know their materials. But the former consults his emotion and fancy; the latter his reason and precisely measured data. Is cold stone an appropriate medium for expressing passion? Every great work of architecture answers in the affirmative. The fact that these creations could not bear their own crushing weight were it not for the engineer's skill does

not imply that the artist is superfluous. Rather here we have a just division of labor. The engineer supplies the practical needs and the artist the poetic and imaginative needs.

As one stops to think how the scientist with his positivism, with his insistence on measuring, has discarded one quaint myth after another which served so well to furnish a none too hospitable world and make it cozy and habitable, one wonders whether, in the end, the artist and poet and all the other myth-makers will be driven from our modern commonwealth as Plato long ago reluctantly expelled the poet from his republic. Philosophy without theology loses its bright wings and becomes, like the other disciplines, an earth-bound thing. Will the literature of the future lose its quaint devices and whimsicalities and substitute mere exposition and scientific description?

What defense can the artist put forward for calling granite the eternal stone when the engineer warns him that it will perish in a myriad fragments if attacked by fire? Most artistic judgments rest on the vaguest of traditions. Mankind comes to love an old error once it has grown mellow and close-knit with human experience. Are these literalist engineers finally to destroy architecture altogether, picking it apart as the critic has already done with religious antiqui-

ties? Will the chapters on emotion in the psychologies finally crowd out all poetry?

A practical world cannot dispense with the engineer. But a world that still feels and imagines will need the artist. In the modern current the artist's vagaries which he puts forward as judgments about materials contrast unfavorably with those of the engineer, chemist and physicist. He is constrained to argue his case in practical terms, though this is a tongue to which he is alien. If he is at times wasteful of brick and steel, he may nevertheless urge that it is the quintessence of practicality to keep the imagination vividly alive and the senses swift to kindle emotion, for only with faculties thus quickened can man continue to invent and push forward his scientific conquests. With the practical social value of art thus stated the artist may be suffered to ply his architectural trade within the strict limits of the building code.

The glyptic qualities of materials show strikingly in what they do to design. Imagine a bit of ornament contrived by some draftsman with no thought of the medium in which it was to be executed, a lamentable situation of not infrequent occurrence in the best of drafting rooms. A bewildered builder presents samples of the same design executed in marble, sandstone, terra cotta, concrete, oak, iron, bronze and glass.

What are the results—one and the same design in each case? On the contrary we discover eight designs which are variations of the same theme. Marble is very fine grained and may be carved with sharp thin edges. A floral design in marble may be made as crisp as the leaves of the actual plant. On the other hand marble is brittle and too bold relief courts disaster if the design is to endure. Sandstone is more granular and crumbling. In this medium the detail must be suppressed and the design formalized to its simplest elements. Terra cotta is plastic, a material molded, not cut with the chisel. This plasticity brings out the flowing lines of the design and tends to obliterate the hard meeting of the planes. Concrete is another cast material, but unlike terra cotta it has a coarse stony grain. With this the design loses all delicacy and concentrates on large effects. Oak may be carved with a sharp tool in almost any shape, but always a rugged longitudinal grain asserts itself, resisting cross cutting but yielding with the fiber. Wrought iron produces a spiky, rigid design and permits the leaves to be hammered out as thin as in nature herself. Bronze must be cast, but will take the most intricate of molds. Finally, glass is blown and molded hot. It may be drawn out into the thinnest hairs but always its lines are plastic and limp.

Some of these materials give to the theme a rough, vigorous texture and others are smoothness itself. All but the last are opaque. Some permit a very wide range of color, as does terra cotta. The coarser ones demand a larger scale, while crystal may take the design as an intaglio for a ring.

No one can gaze on this exhibit without becoming a hylozoist. Indeed one of the infallible signs of a good artist is his instinct for adapting his designs to his materials without doing violence to their living nature. The amateur or the bungler despotically tries to carry out his artistic whims with a high disregard for the medium. But the master artist knows that he must obey the commands laid upon him by stone or metal as the price of his mastery.

Texture and color—these are qualities of high emotion. They transmute architecture from cold forms to an art of still passion. The poet Goethe did architecture a great injustice in calling it "frozen music," a phrase which has stuck to it ever since. Architecture may be mute music, but its most formal and austere examples hardly deserve the adjective "frozen." For this word carries a repelling connotation connected with a process that is life-destroying. Once its forms have been embodied in living materials, even though they are conceptions of logic and

reason, architecture becomes a passionate art, as warmly human in its appeal as music or painting or poetry.

Color, the appearance of vibrant light, we already know as the painter shows it. The architect, however, has a color technique of his own. His compositions must bear critical comparison with nature herself. They stand under the open sky, exposed to the naked sun or dulled by clouds. Rain and biting sleet destroy pigments with grim delight. For this reason, the architect rarely trusts to synthetic man-made color applied with oils to surfaces. Instead, he usually employs the colors he finds in nature's materials. These blend best with natural surroundings. These retain their pastel hues long after their surface is worn and furrowed.

With this apology for the paleness of architectural coloring, one must admit that the modern architect until very recently has been timid about the warmer hues. The Greeks, whom we often think of as the most austere of builders, delighting in ghostly temples of white marble, have gained this reputation from the reports of early archæologists who saw only the faded ruins of their civilization. We may judge how gorgeously the Greeks were wont to color their temples and even their statues by visiting the new Philadelphia Museum of Art, the beautiful

terra cotta pediments of which, with their rich color, would probably seem far more natural to the Greek than our sepulchral colonial architecture of snowy whiteness.

Chinese architecture is noted for the brilliance of its color. One thinks of its subtly curving roofs adorned with tile of jade, turquoise, and topaz tones. China's stately temples and yamens were decorated with columns of lacquered wood. Roof trusses were as gorgeously painted as the native silks. Gilded and lacquered lattices made the windows radiant.

Our own architecture has suffered from a certain grayness and drabness due more to lack of imagination than to necessity. But contact with the other arts and with the architecture of southern countries has revived the architect's interest in this light-born symbol of emotion. His limited use of color has been due partly to a poverty of materials. Colored marbles have been less abundant here than in Italy. A more severe climate has made applied pigment less permanent. The coming of terra cotta has stimulated the architect's sense for color, and the modern development of ceramics brings the architect all the rainbow hues with which to illuminate his structures. Rather recently color effects in concrete and stucco have offered a new architectural range.

Color is partly a matter of texture, for variations in surface alter tones. But texture is not a single word; it is a whole vocabulary for the architect, who, as a rule, is rather tongue-tied away from his drafting board. Sometimes texture means the qualities evident to the blind man's sensitive finger—roughness, smoothness, grain, porousness. Sometimes texture is the shape of the stones and the way they are laid and pointed, an aspect discerned primarily by the eye. Broken ashlar has a characteristic texture and heavily rusticated stone another. Often texture means simply color variation. In brick work, in order to gain a pleasing texture, the architect will blend half a dozen shades of the same color, or will introduce dark hard-burned headers with lighter stretchers. Here, too, it is partly a matter of the pattern of color and shape which make up the surface. If the wall is interesting in any way it has texture. The word serves until some fluent genius shall coin a new set of terms to convey its different meanings.

Much of the monotony of bad architecture arises from a mechanical and disrespectful use of materials. Brick, of all the stuffs of building one of the most gracious and humane, was manufactured and laid with such characterless precision by the last generation that it became one of the ugliest materials imaginable. The modern

predilection for that dull but respected variety of limestone quarried in Indiana is another example. As in the case of the brownstone of our grandparents, the indiscriminate use of this material betrays our Philistine indifference to æsthetic values. To be sure, this limestone has the polite merit of being easily shaped, and for classes of work which require delicate detailing and little character in the material, it is well adapted. But its chief merits are of the negative sort arising from its lack of qualities. It is monotonously uniform in color, texture and character, causing the designer and worker far less trouble than more interesting stone.

Architecture has suffered greatly from the passing of the handicraft period when sympathetic hand labor prevailed. The impersonal machine treats all materials alike and turns out a standardized and monotonous product. Wood and stone are now shaped to the builder's design in great mills which they pass through almost untouched by human hands. If production is swift and mechanically perfect, it is also supremely uninteresting. Engineering has triumphed over artistry. The premium is placed on similarity, not on individuality and character. Not infrequently to-day these are obtained by highly artificial and absurd means. Sawn timber is hacked with the adze to imitate the handicraft of an

earlier time. Machine-smoothed stone is defaced by the workman's hammer to give it a primitive appearance. Such imitation is worse than the mechanical product of the mill.

Now that the machine dominates, the designer must frankly recognize its limitations and possibilities, striving to conform to the one and develop the latter. Architecture, like Lot's wife, has ever been constrained to glance backward at classic Sodoms. And it has been as frequently turned to stale pillars of salt without the vitality of the living stone. This attachment to the past is most apparent in design, but it also crops out in the treatment of materials. The hard metallic touch of the machine can never imitate the softer touch of the tool in the workman's hand. If materials lose a portion of their interest in consequence, this must be made up by the poetry of design.

Perhaps the greatest loss which modern architecture has suffered from the advance of science is that design has been transferred from the stonecutter's yard to the remote drafting room of the architect. The Gothic carver worked out his quaint conceits in company with his medium. Stone and carver combined together in a kind of partnership to evolve forms that were more eloquent than either dumb stone or human imagination alone. This intimacy with

materials is forever lost outside the small, artist's studio. Man has now gained the absolute mastery, and has debased his former allies into slavery. Materials have surrendered their stubborn autonomy which made older buildings a proud triumph.

Of all the artists who work on a building, time and weather are probably the most gracious in their touch. The difference between good and inferior materials is largely to be measured by their response to weathering and wear. The beauty of Chartres from the exterior is partly due to the silver gray of its weathered limestone blocks. Old stone takes on the hoary aspect of age. The separate stones appear to grow together. Moss or lichens cling to them as they do to the natural rock, restoring to the cut stone its former informality. Even so perishable a material as wood weathers admirably. Such a practical and prosaic thing as a shingle weathers into an article of charming tones and boldly furrowed grain. Copper takes on a brilliant green patina. Brick softens and mellows in color. Polished wood or leather acquires a richer hue with each passing year.

A new building never is completed until it has received the mellowing touch of time. In this sense no piece of architecture ever is complete until the sun and rain of a century have tinted

and sculptured its surface. When wandering in Europe the American architect frequently is struck by the advantage that these old designers have had, whose conceptions may be properly judged from the vantage point of a century or more. In New York, where the average life of the best type of fireproof building is estimated to be scarcely thirty years, architecture has no opportunity to ripen into beauty. Its charm must be contrived synthetically by giving materials the guise of an age they do not possess in fact.

A building is like the living tree that takes root in the soil in which it is planted, adapting itself in a thousand subtle ways to its immediate environment. Parisian architecture taken in its entirety—with rare achievements, such as the Tour St. Jacques, or that stern old spinster, Notre Dame, or the sophisticated and urbane palace of the Louvre, all averaged in with the city's mass of structures—is not beautiful, picturesque, original or imaginative. The decayed ritual of the renaissance has clothed the city in an inexpressive and mundane formalism. Yet magnificent city planning and above all a decent amount of age gives Parisian architecture a gracious dignity that makes a background by no means drab for the sparkling vitality of Parisian life.

Only in London has the touch of time been sordid and degrading. Not all observers will agree with this personal judgment. Yet the presence of soot and fog together have combined to concoct a murky stain that bedraggles every structure, however distinguished it may be, giving it a shoddy factory appearance. London architecture is by no means characterless or displeasing, but it has had to struggle against this filth of surface which tinges the noblest mansions with the mark of commerce and trade. Time and the elements have been unkind to London and if it has retained a kind of stern respectability in spite of this disadvantage the more credit does it deserve. For beneath its dingy exterior London is a noble and kindly old city, which to the American offers the indulgent affection of a great-grandparent.

A good many factors contribute to our love of the antique and the picturesque. But chief among these are the characteristics which weather and wear have written on the honest face of sound materials. The old cathedral we have come so far to see may have a shockingly secular air, more reminiscent of municipal pride and defiance than of medieval spirituality. But with age even arrogance may soften into dignity, and pride be translated into nobility. If it is hard to

worship the other world in these sanctuaries, we may at least reverence the present one.

Perhaps the most striking proof of the part that age-worn materials play in our delight in architecture may be observed in the many restorations which have striven in vain to recapture or preserve the spirit of the past. Some future generation may find them lovely and worthy of pilgrimage, but to us who see them in their callow newness, they are ever a dismal disappointment. Old St. Denis, the burial place of kings and haughty queens and knights as well, rears a plain but picturesque façade which to the initiated tells the tale of the bold transition from the Romanesque to the Gothic, but its interior, restored by no less reverent a hand than that of Viollet-le-Duc, is inevitably disappointing. So are the cathedrals of Angoulême and Périgueux, the fortress of Carcassonne and other buildings heroically rescued from oblivion by restoration. At best the restorer is but a poor biographer. He may record the facts of a living architecture that once existed, but never the thing itself. Immortality, architecturally speaking, cannot be achieved by reproduction. It is rather the gift of chance or of the gods.

This lament for the ways and things of antiquity may fittingly be concluded by a reference to the geography of architecture, a profound

and intricate subject, only certain aspects of which will occupy us here. The old builder, aided by patient oxen or slow-moving barge, might transport his materials but a short day's journey from the place of their formation or growth. The stone was quarried nearby and the oak for the timbers grew in the forest within sight of its new place of eminence. Architecture, as a natural consequence, was a creation of the locality in which it flowered, an offspring of the very rock and soil. Thus in studying comparative architecture of an early time, we perceive that peoples who had no stone were forced to build of brick, and those who had no wood were obliged to split heavy lintels from the quarry. The grandeur of Babylon arose from the mud of the river banks. As brick and rainbow tile this humble silt grew into broad walled cities, hanging gardens, and towers that pried into heaven.

To-day architecture has lost this folk intimacy with the birthplace of its beams and masonry. Modern architecture is expatriated. It is a mixed assemblage from all parts of the world. Perhaps it would be fairer to say it has developed, from the peasant loving the soil on which he was born and nourished, to the cosmopolitan claiming the whole planet as his home. Like the citizen of the world, architecture has lost its quaint national

costume and local traits. Less and less it is built to the site. Instead the site is modified to suit the building. Stone and steel are brought from many miles away, even from across the sea.

Not that this is altogether bad. With the change architecture has gained a regal power. It may command the varied markets of land and sea. No longer does it bow to local restriction and prejudice, to the poverty and meager natural resources of its locality. With the loss of individuality has come majesty of size and of resources far beyond the capacity of ancient builders.

But transportation and world trade have not altogether set at naught the geography of materials. Climate chooses with nice discrimination the stuff of which human abodes shall be fashioned: in Scotland gray bleak limestone, in Italy warm-toned marbles, trees felled and squared for Norway and Sweden, steel for urban America, brick and tile for China, and bamboo for tropic lands. In hot countries, where the white ant treacherously eats away the strong heartwood of beams, reënforced concrete endures. Stucco, with its plastic compliance and its sunny surface, also is a favorite of warm climates where there is no frost to peel it from the walls. The thatched cottage, safe enough in the

moist island climate of England, becomes a tinderbox when reproduced in New England, so that the colonists enact as their first building law an ordinance against its use.

Color follows the sun. Where its rays are the brightest there the buildings usually are gayest and lightest in tone. Saracenic architecture is jeweled with colored tile. Sunny Italy chooses colored marbles. Spanish America loves its bright tile roofs and tinted stucco walls.

Northern countries usually have been more diffident about color, though the generalization has enough exceptions to make it pleasantly hazardous. And one of the most vivid of these exceptions is the stained glass of medieval northern Europe. Chartres, with its ascetic saints, its sober gray limestone, its stern Norman façade and right tower, and its general air of monastic severity and rule, provides the setting of stained glass more radiant and colorful than any southern artist's work. Here is still, glowing passion, all the warmth and gorgeousness of the sun caught in the artist's rainbow. A vibrant sapphire blue dominates, piercing the dimness of the lofty vaulting of the interior with heavenly light. For those to whom the hylozoism of the artist seems a fantastic and unreal doctrine, at Chartres seeing is believing. These windows make one credit the lesser miracles of the church.

With the normal world transfigured by such color, skepticism is out of the question.

But it is to the south that one must travel for walls as beautiful as flesh and for jeweled mosaics. San Marco and the Ducal Palace at Venice have a sensuous beauty well nigh as intense as the spiritual ecstasy of Chartres. For this city of merchants and traders is interested in the beauty that may be bought with gold. Rare marbles, pure gold leaf, and costly Eastern workmanship here are lavished to the glory of the mistress of the sea. The domed cathedral is not dedicated to the Virgin, for these folk would hardly have understood so monastic an ideal. Though it bears St. Mark's name for good manners, it is actually the shrine of a luxury-loving urban mistress greedy for the fine stuffs and rarities of the East. How plainly all this is said through the eloquence of marble, snowy white or delicately pink, woven into silken designs more like gorgeous fabric than hard masonry. The palace and the cathedral belong side by side, for both are secular except in name.

As one recalls these splendors one wonders when man first began to note the æsthetic qualities of materials. Was it in some gaunt menhir of the Druids now marked with the outline of the cross, a stout old heathen of the Stone Age converted to Christianity by the hard point of

the believer's iron chisel? Did these dawn people reverence the stone for its own sake? At Le Mans, in one corner of the old Romanesque part of the cathedral, there is such an ancient stone which must once have been sacrificed and prayed to by the former folk. Did these people think of the stone only as the abode of a powerful and possibly malevolent spirit?

Certainly this admiration for the materials of building goes back very far. Man has loved marble, the precious stone of architecture, since time immemorial. Of this the most glowing with life is alabaster, which adorned the walls of palaces. The Egyptians carved their statues of dark basalt and green serpentine and colored granite. Wood as well as stone has been appreciated as worthy of high regard. The oaken roof beams, the door post pivoted into threshold and lintel, these have been worshiped both as strong wood and as symbols of the home.

One only has to repeat the names of woods to feel the delight we take in them themselves. Mahogany, rosewood, ebony, walnut, satinwood, boxwood, sandalwood, teak, and of the commoner woods, redwood, oak, cedar, cypress, white pine, fir, maple, chestnut, bass, whitewood, gum, birch, hemlock—each of these names is a poem of one word. Each calls up a picture and

associations that begin with our first remembrances.

Among heirlooms inherited from our grandparents are fine mahogany highboys and secretaries. The cunning cabinetmaker arranged the florid, swirling grain into symmetrical patterns by opening out the thin sheets of veneer like sheets of a book so as to place the faces sawn apart opposite one another. He tinted the red-brown wood to deep maroon and covered it with the gloss of old varnish. Its secret drawers, fine dovetailing and joinery are appealing, but it is the mahogany itself that gives gentility to the piece.

Or to choose at random certain others, redwood, oak, cypress, cedar—these are the enduring woods. With these belongs teak which we can imagine floating down the Mekong river from its jungle home and at last reaching the lumber yards of Hong Kong, there to be cut into thick planks by Chinese coolies, one standing above the log, the other crouched below, pulling back and forth with even rhythm a long band saw. Finally this noble lumber reaches Europe and becomes the ship's rail which we lounge against as we cross for a summer's holiday. There it defies the driving salt spray which corrodes and eats away the thick steel plating.

Some materials are newer and have not ac-

quired much æsthetic characterization. Concrete, for example, is but beginning to build a reputation after serving in lowly and hidden capacities at least since Roman times. To-day we are learning to give this man-made rock as interesting texture as if it were the product of nature's unhurried manufacture. Terra cotta, another man-made material which is both ancient and very modern, has lost its staring white glaze under the alchemy of the artist and is introducing new tones into modern architecture. Our long use of ceramics for other purposes has prepared the way for this gaudy architecture. Perhaps the porcelain pagoda of China may be a prophecy of the way our terra cotta towers will develop. The range of color and the ease with which the clay may be molded promise the artist high achievement in the future.

But our century is one of metal. Metal is the material that best symbolizes the spirit of our times. Copper, bronze, and gold taught man the early arts of civilization. Iron gave him power. But the coming of steel really marks the beginning of his rule over nature. To-day signs are not wanting that aluminium, that soft virgin among the metals, so light and yielding compared with the masculine steel, may bring in a new age.

Copper and bronze have always been the work

stuff of the artist, his favorite metals—red copper which could be beaten into shape and olive bronze that could be poured into a mold. Less perishable than the stronger iron, they have perpetuated many a work of art through the ages. No noble building is complete without its portals of bronze. Here is a metal for architectural use that is fearless of the elements, that may be polished, or left to verdigris in the air.

But bronze is a metal of antiquity. To express the passion of the twentieth century we must choose steel as the symbol. This of all the architectural materials bespeaks the mechanical power, the structural pride, the hardness of our civilization. Let the architect who would immortalize our age conceive his design in mounting steel columns, in steel girders, in steel cables spanning mighty rivers. Steel is the material for the titan architects of to-day. Steel shouts aloud the daring irreverence of our age.

VI

LANGUAGE WITHOUT WORDS

Style

In addition to the many other confusing tongues of architecture, there is a distinct group of languages spoken by design. The linguistic of design is style. Here is a rich range of languages without words. Their vocabularies consist of line and form, of light and shade, of texture and color, of materials and construction. They speak silently without the transient agency of sound.

What is style? In poetry and painting it may be the artist himself speaking with a new voice born with him, individual and unique. But in architecture it is not a thing of persons or even of nations. It is the language of form spoken and understood over wide areas. It is a tradition enriched by many past designers ready for creative interpretation according to present needs. It is an accepted means of artistic communication intelligible to artist and layman alike. Style might be defined as the ritual element in an architectural composition. Style is learned, not invented. The correct handling of style shows education, not ability to originate. It may be

contrasted with design which is the creative part of architecture. Design is the artistic invention of the architect, and gives to his work its unique character. In architecture, style and design are subtly blended, for novel design is usually expressed in traditional style.

Architectural design has its dead and its living languages. The Babylonian style died with Babylon. Egypt is architecturally as dead as her ancient kings but like them her architecture has been preserved for modern generations to wonder at. In America the Mayan architecture died with its peoples, but still stands as almost the only memorial of their civilization. The architecture of old China with its frame of round logs and its curved tile roofs, is an ancient style that seems destined to die in the present generation unless it is revived by the patriotism of young China.

The main stylistic languages are comparatively few though the variants and local dialects are multitudinous. To-day America and the western world speak a corruption of architectural Greek. To be sure it is not very intelligible Greek after having been partly Romanized during the Empire and garbled during the renaissance, not to mention the liberties which we have taken with it in modern times. Its classic purity is gone and

many a barbarous element has mutilated it, but for all that we speak Greek of a kind. It bears about the same resemblance to the mother tongue that modern spoken Greek does to Attic Greek.

The languages of the architectural styles have their fixed rules of grammar, their accepted usages which no one but the greatest of artists may venture to break. And even he, like Michelangelo, is likely to be anathematized by future generations for corrupting the purity of style out of sheer wantonness or vulgarity. Like all language, styles are growing, changing patterns of communication. But the price of intelligibility is that they shall grow very slowly indeed. For no generation is willing to learn many new words or expressions. Each prefers the old familiar ones. If new terms are admitted, they are likely to enter surreptitiously at first as slang expressions, pert corruptions which in the beginning amuse us, but which finally stay to serve us.

It is as inconceivable that an architect should suddenly create a building that was wholly original and new as that a poet, bored with the worn and commonplace language of his fathers, should suddenly coin an entirely new one. If he retained a phonetic alphabet, it would be possible to read and enjoy the music of his verse but no one would understand him and even the music would doubtless sound garish at first. Occa-

sionally an architect has almost accomplished the inconceivable and burst forth with a style that was largely new. But these are rare exceptions in architecture.

Language always has a strong ritual element and in repetition there is more of delight than of boredom. The critic longs for a new style but if by some miracle it came, he would not be able to decipher it. All language is compact of customs which must be nicely observed. The grammarians do not fetter language; they but voice the popular sense of propriety in the use of words. Generally speaking, literary folk themselves are the high priests of linguistic ritual. They are the purists, the exponents of grammarian virtue.

Etiquette plays a leading rôle in all design. Public taste is always primly watchful for the stylistic libertine. Slight digressions from the conventions of good form may pique the interest, but the wages of sin are death in matters of major stylistic concern. Woe to the capricious young designer who experiments with Gothic tracery shaded by a Greek portico! Unless he can point to some amusing transitional prototypes of the Jacobean or Francis I periods, his sentence for such barbarism is sure to be deservedly severe.

Not that public taste in matters of architec-

tural decorum is commonly at a very high level. Convention is as apt to set up a thoroughly debased standard as a worthy one. The dark days in America from the Civil War until the Columbian Exposition in Chicago, which relit the torch of architecture, are eloquent enough witnesses of this fallibility. The brownstone houses of New York still stand as memorials to the vulgarity of our grandparents' architectural manners. Conformity rather than excellence is the homage exacted of the designer.

Too often style is spoken of as something archæological, as part of the retarding past. Or it is thought of as a dead form killing any life it may carry in its womb. But this criticism misses the function of style completely and is based on a false conception of the nature of creative art. Architectural style is the tutor of the young artist, teaching him his letters, his words and how these are put together into sentences. To speak correctly involves considerable restraint. The words he learns are inevitably old words. But without symbols of expression the young artist would be mute. The vocabulary of art is as ancient as man. And so are many of its materials.

Creative work is not a matter of whims and fancies as so many sane critics seem to suppose, but a fresh and imaginative interpretation of

the law. The artist employs logic and intuition in equal proportions. His flights of fancy do not end in disaster because he has mastered the rules of aerial navigation. Like the Creator of this world, the artist works out the variety and novelty of his conceptions with the aid of certain uniform principles. The great artist uses law as his instrument; only the slavish copyist is cramped and bound by it.

Time and race experience have forged out strong languages of line and space. Few nations have been vigorous enough to make a style wholly of their own. No architect has ever been able to do so. The virtue of architectural styles as vehicles of expression is their cumulative power gained by slow accretion through the cycles of history. The architect of to-day speaks with a voice intensified by all those who have used the language before. His words are enriched by connotations and associations that have grown up through the centuries. Abstract forms become concrete symbols of experience, taking on a fine patina of antiquity.

We live in an age of linguistic virtuosity in architectural America. To be sure, some of the varied tongues which our highly schooled architects employ with a considerable degree of fluency are affectations, mere pedantry in design; others, however, are spoken with some assur-

ance and inherited right. Our polyglot buildings are characteristic of a period in which language in design is changing rapidly. We are seeking through lingual experimentation to find a mode of expression characteristically our own.

We have seen that the canons and criteria of public taste find expression in the grammar of architectural style. An example of such a generally accepted judgment is the rule that the entablature of a classic order shall be a fifth of the total height of column and entablature together. It was a Roman rule which the Greeks always disregarded as far as the Doric order was concerned and varied considerably even for the Ionic and Corinthian. Similar rules were worked out for the proportions of the other parts of the order so that the whole became, especially in later times, a spacial ritual punctiliously followed.

Why were these rules rather than any others chosen? A good many incidental factors, such as the limitation of materials, the practical needs of function, the expediencies of construction and cost, entered into the choice. But the main factor was custom. A certain precedent once set became the rule. A linear rhythm that was familiar pleased more than wholly new relations, because it was more easily understood. Recog-

nition as well as discovery accounts for our delight in design.

Can we push the inquiry farther and ask whether in the physiology of the human organism there is any imperative need for a given proportion? Many have sought to do this and professed to find a survival value in the choice of the one particular design above the limitless range of possibilities at hand. But the proof of this biological basis of art has a fantastic pattern. Perhaps design is not wholly fortuitous. It may be conditioned by the artist's organism and the other factors mentioned above. But beyond these apparently safe generalizations, we have yet to penetrate. Style is a manifestation of ancient ritual. How that ritual grew up we can accurately report in the case of styles that have been more thoroughly investigated. Why it grew up is still a mystery.

The rules of architectural grammar which govern style represent the consensus of opinion in a given period as to what is beautiful, well proportioned, appropriate. No more absolute or universal rule of fair form can be stated, for taste changes radically from one century to another. The enjoyment of a bygone style depends on education, upon learning the language of the period.

From the point of view of architectural style,

beauty is the correct interpretation of an established convention. Beauty is a kind of good manners, not imagination. The most beautiful building of a given style is the one which employs the language and grammar of a period most gracefully and fecundly, not the design which is most daring or new. Beauty is conventional, not original. It is the quintessence of good taste judged by a given social standard.

To establish such a standard the public needs long education. The artist may lead public taste but he can never drive it. Usually people are slow indeed in changing, in learning a new foreign language. Occasionally, however, there will be a sudden shift in speech even in architecture. For example, after the classic revival that followed the Georgian style of colonial days in this country, there was a marked revolt in the interests of self-expression which resulted in a reign of architectural anarchy that lasted half a century.

To speak of beauty as conventionality and taste as a product of education threatens architecture with a distressing relativity. Art loses its eternal qualities and becomes the work of human artists. The absolute, driven first from philosophy, then from theology, now surrenders its last stronghold. The eternal art endures no longer than the memory of man. It turns out

to be the changing expression of his fickle taste and fancy. If it is a part of the world order, it is a part ordained by man for his own satisfaction.

In a certain sense architecture does have a permanent character. For a language used by the race in its infancy always has a special charm for the race in its maturity. Man's first utterances in stone are better loved to-day than many of the more magnificent creations of our own time. They have a sacredness that comes not from a supernatural origin but from being man-made so long ago.

Do we really believe that beauty is in its essence a suave accedence to convention? One need only study the prize awards in the architectural competitions of the past to see how supreme a mistress is the prevailing taste. Or travel across the frontiers that separate country from country and see how different a costume beauty wears. The Englishman is appalled at our American architecture, not because it is bad but because it is so different from the stanch low walls of London.

We travel abroad, not in search of beauty, but in quest of new beauties different from our own. As we learn these new and strange languages of form, our taste is broadened. We compare one beauty with another and find the heart responds

to more than one appeal. Loyalty to a single standard is provinciality, not virtue.

Now and again some particularly vigorous style will capture popular taste and intolerantly banish all others. In our architectural schools the neoclassicism of the renaissance has held despotic sway. A public building without classic columns hardly seems loyally American.

For many centuries Greek sculpture has set our standard for beauty and not until recently, when an increased acquaintance with Egyptian sculpture and Negro wood carving began to emancipate us, have we escaped from the most abject subjugation to the Venus de Milo. Similarly architects have continued to worship at the Greek Parthenon and the Roman temples, regarding all other faiths as pagan.

Sometimes a dead language will survive for ritual use as did Latin during the Middle Ages. Gothic architecture, though long a dead language, still is the accepted mode of expression for the church and the university. This language of the age of faith fortifies religion in a skeptical and positivistic age. The schoolman, more interested in knowledge as the slow accretion of the past than as a present enterprise, finds in the Gothic an appropriate symbol. For the schoolman of seven centuries ago held exactly the same view.

The modern architect is a target for a good deal of criticism because of his versatility. Why does he copy the styles of the past? Why doesn't he originate a distinctively American style? Why does he bother with these conventions at all, when the essence of architectural style is simply the expression of function, structure, and materials?

The first question is hardly stated impartially. There is a certain unfairness in the word "copy." For the majority of people are always copyists in that they follow the leadership of the few. And architects are no exception to the rule. Not many architects are great creative artists, though the average in America is surprisingly high.

But to copy further implies that the adoption of a past style is an admission of artistic impotence. Style understood as a pattern fixed by certain ancient models or authorities, such as the architecture of Greece or Rome, would certainly involve copying of the most servile sort. But style recognized as a language, classic or modern, may be chosen as a means of expression by any artist without fear of being condemned as unoriginal. The fluency and vigor with which he handles his chosen language, not the language itself, will be the measure of his creative power.

The competent architect no more copies other styles than does the author who writes in French

or German. Language always implies mimicry of a kind, but this has little to do with its use in the hands of an original writer. The architect does not copy when he speaks the tongues of Byzantium, of Tudor England, of Provence and Lombardy. Our eclecticism does not arise from our lack of invention but from improved communication with the peoples both of present and former days. It is as natural for the modern architect to speak half a dozen style languages as it is for a Swiss to answer in whatever tongue he is addressed. Improved scholarship and a world acquaintance have banished forever the local dialects in design. Purity of style, in the sense of a single architectural manner, implies ignorance of others and isolation. Along with local costumes, petty nationalisms, and foreign prejudices, *genre* architecture is disappearing from the world. The local languages of art vanish and only the few strongest remain.

The second query as to why the architect does not invent an American style also betrays some bias in the wording. No one has yet suggested that Americans should invent a new vocal language of their own, though purists have frequently condemned them for doing so. The American writer manages to write characteristically and freshly in a tongue that goes back as far as Chaucer without major changes. Why

should not the architect import his design language from the old world, as we have our spoken one? Surely he cannot be soundly criticized on that score as long as he expresses himself in tongues that are generally understood. A few writers already turn from English to French or German with equal ease, and quite likely, as the world shrinks in size, this versatility will became as common in speech as it is in architectural design.

As a matter of fact, when the American architect speaks the Gothic tongue, he gives it a form that in no way resembles medieval usage. The Woolworth building typifies modernity for all its Gothic design. The lacy tower of the Harkness memorial at Yale University is rendered in academic accents which closely recall the old Gothic language. But even here an old theme has been handled with such artistry that it is new and vital.

This alone should be sufficient answer to the demand for a unique American architecture. But signs are not lacking that what actually is a new language may be in process of becoming. Already the dialect of America, architecturally speaking, is distinctive. New subject matter—the skyscraper and the great industrial structures —have forced us to devise a new vocabulary and new figures of speech. We speak the old tongues

differently, and we have evolved certain rules of grammar which one notes in all American work, regardless of the language in which it is couched. The new American style seems to be springing from the blending of old styles, from the use of new materials and the solution of new problems. Examples which occur in New York are the Hotel Shelton, the American Radiator Building, the New York Telephone Building, and the Medical Center. These show a decided break with the past, and are prophetic of America's future.

The third query is more an *ex cathedra* dictum than an interrogation. Does good architecture consist in the frank expression of function, structure, and material? Is style a consequence of the application of this rule? As is ever the case with dogmas, the difficulty is one of interpretation.

The dictum asserts that style and design in architectural composition consist only in revealing the way a building is used and the way it is built. But the architect's task is not as simple as this. His design starts with function, structure and materials as the data or given elements in his problem, though it by no means ends with these. It is as if we said that the sole task of the painter is to faithfully copy nature, rather than that the artist begins with nature as the

raw material from which he derives his composition.

Between these two positions is a vast though not always recognized difference. Function, structure and materials, taken alone, will only produce a useful practical tool, not a composition that is æsthetically attractive. The architect's task as artist is to give to these elements visual significance. The practical subject matter and working materials must be transformed by creative imagination into art. To be intelligible, the rule should be re-worded to state that good architecture is an *æsthetic* expression of function, structure and materials—not a crude exhibit of these elements. For hidden in the word "expression" is the artist's vision with all its power of invention and organization.

In his *Poetics,* Aristotle says that one pleasure in art is the information it communicates. The musician is the only artist who ever completely escapes from the troublesome problem of subject matter, though even he forsakes the purity of complete abstraction now and then. Architecture is representative of the institutions for which it is constructed. Though the design may seem as abstract as any music, the building is a bank, a church, or a school.

The designer should concede that in architecture, he is forming and enriching a tool, that his

design should enhance, rather than detract from its serviceability. Naturally he will not wish to obscure its function. He will, as architects say, strive to express its plan in the elevation. But this does not mean that the principal features of the plan or structure invariably should stand out starkly in the façade. In the natural course of events, the exterior may mirror the interior. However, if it does not, through some exigency of the site or æsthetic need, the design should not on this account be condemned.

The rule has its basis in sound logic. It recognizes that architecture is for use, not simply an imaginative composition of the artist. Design ought not to disguise or interfere with the purpose of the building. As a safeguard against extravagant conceits, the regulation is well conceived. But it has sadly misled a host of naïve critics, causing them to confuse bleak functional elements with fine art. Architecture is practical art expressed in the decorative form of fine art.

In the early days of architecture the literal expression of structure was inevitable. It controlled design, body and soul. The builder sacrificed all, utility and beauty alike, in his effort to make the building stand. But these are no longer the simple times of post and lintel or pier and pointed arch. To-day conditions have changed. The engineer can work out a structure of almost

any size or requirement. His trusses and beams and columns are linked together in far too complicated an ensemble for the eye to grasp. But the artist's design must be simple as a concession to the naïveté of the mind's eye. The chief elements of the design must be grasped at a glance. There is no time for complicated calculation with the slide rule or study of blueprints.

So the artist does exactly the same thing with the building that he does in portraying nature. He simplifies both, bringing out the artistic essentials. These may not very closely resemble either the structure or nature respectively. This is not important. One trusts the engineer to handle his concrete and steel competently. What the eye enjoys is the towering masses, the rhythmic planes, certain main lines of force rising skyward. The inner anatomy has only a technical interest.

Here, too, the cardinal point is that there be no rivalry or clash between engineer and artist. Each may make some concessions without practical or artistic loss. If the engineer has planned a column on center and the artist finds the entrance cannot be moved to either side without æsthetic detriment, he will ask the engineer to carry the offending column on a deep steel lintel above the door. The column that is hidden and does not run straight and true to a base on the

foundation, is quite as honest as any other column, assuming it is figured to carry its load safely. To call this architecture deceitful would be stupidly literal.

The design of the artist gives to architecture its mute eloquence. It kindles the imagination, sense and emotion, making living spontaneous and the mind supple. If on occasion design pays scant respect to practical requirements, the result may so far justify the transgression as to avert censure. With a hard-headed people, the design will but rarely be granted too much freedom, whereas the instances in which its soaring wings are mutilated are too common to excite pity.

Style is a cumulative product of creative designing. It is the heritage from generations of spacial thinking on the problem of translating the gross elements of function, structure, and materials into fine art. To reduce it to these elements alone is like reducing a painting to canvas, pigments and oil.

How do styles originate and develop? The birth of style is always in secret. No witnesses are present and the event is not heralded until long afterward. When did spoken English or French begin? Not with Chaucer or Montaigne, for both languages were already old when they wrote. Sometimes a Dante will forge a new

language. Modern Italian seems sprung from his singing pen, but he had the vernacular tongue and the songs of the troubadours ready at hand. He but captured this oral music in written verse. Architectural languages are as elusive in their beginnings, and merge into each other by gradual degrees.

Behind the classic perfection of Greek architectural expression lies a long vista of Egyptian and Mycenean culture. Some time in the dim past the Greek columns of marble or travertine were stout trunks of trees, the architrave a hewn beam, the triglyphs that adorn the Doric frieze the ends of ceiling timbers, the lines of the cornice moldings the ends of roof boards. At least so the archæologist has shrewly guessed. The homely pavilion of wood became the temple whose exquisite proportion is the symbol of the subtlety and refinement of Greek thought. Here the strictly structural beginnings of the style are clearly apparent. The materials change from wood to stone, two materials as unlike as night and day, yet the pattern of the design is not altered. Nor did our forefathers in this country find it necessary to vary proportions when, during the Georgian and classic periods, they changed from the carved stone of England and the continental renaissance back to the original wood. The perfected ritual of the de-

sign dominated, with little regard for the materials.

Greek and Roman architecture differ not more in style than one would expect from the circumstance of an aggressive, leather-skinned nation copying a sensitive and refined people. Roman construction with its employment of the arch, the dome, the vault, its use of concrete and of facing materials such as brick or cut stone for walls of rougher stuff, is as different from the simple, trabeated construction of Greece as are the Roman people from the Greek. The layman hardly realizes how striking this structural difference between Greek and Roman work actually is, because the designing is so similar. Yet allowing for the inferior Roman workmanship and the pedestrian Roman imagination together with the more complicated social organization which needed more complicated buildings, the two styles are the same. The Romans originated no new element of design and abandoned none.

These facts have always been bitter pills to swallow for functionalists and structuralists from the time of Ruskin down. One would expect to find that the revolutionary Roman construction and highly organized life of the empire would evolve a style strikingly new, if style depended on these factors alone. But the case of the Greeks has already established that construc-

tion and function are not necessarily dominant factors in shaping style. The traditional academic procedure is to condemn Roman architecture with its columns and pilasters because they are used ornamentally, not structurally. The Romans, however, were very good architects who succeeded in a far more difficult set of problems than did the Greeks. They built soundly, too, else their work would hardly have survived to this day. Roman architecture is great art adequately expressive of the power of an imperial nation. Modern architects, while viewing Greek work with the high reverence such supreme attainment in design merits, have always learned more from Roman architecture because their practical problems are much the same as those the Romans solved. The Romans shaped architecture into varied and effective tools for complicated social life and developed engineering far beyond anything the world had known before. Their genius lay in practical construction, not in artistic creation.

We still continue to use Greek motifs as the dominant decorative language of our day, though there is rarely any genuine structural connection between the classic order and the building behind it. Nor need this practice be condemned. The dignified and stately speech of Greece is well understood and has been ven-

erated anew since the renaissance. If it becomes somewhat monotonous and formal in the hands of the hack designer, it still has power and freshness when handled with the mastery which the Lincoln memorial—a very un-Greek building—bespeaks. But at its best, it will never again reveal the simple structure of its origin.

In writing histories of architecture since Viollet-le-Duc set the precedent, it is customary to point out the influences of geography, geology, climate, religion, society, and history on style. But it is fitting that now and again we re-examine such customary practices to be sure we understand what we believe. These six factors in the consideration of style are not co-relevant. The first three might be described in the terminology of insurance writers as due to acts of God, while the last three are dependent on the agency of man. We may conveniently group them as the physical and the social factors of style.

When left alone geography proves to be quite a linguist, but too often man defies its tutelage. In the brilliant sunlight of Greece the exterior colonnade casts grateful shadows on the glaring inner walls of the buildings. From the aspect of design this expedient makes dramatic and rhythmic shafts of alternate light and dark. It is supremely adapted to a land of radiant sun

and strong reflected light. In London, on the other hand, a colonnade becomes a grim, dour thing. No high lights relieve the face of the columns; no reflected lights show the wall beyond. The contrast of panels of light and dark is nearly lost. Much needed daylight is excluded by the columns which are darkly forbidding instead of ornamental.

Yet good Sir Christopher Wren has planted London with thick trunked columns, and, curiously, we like them! Geographically speaking they are as incongruous as Cleopatra's needle on the Thames Embankment. Geography be hanged, say we! Give us our columns and we will light our dark interiors with electricity. We will make our own geography to fit our favorite architecture.

Geography constantly suggests ideas, which if he would only follow, man would find immensely convenient and comfortable. But he is a headstrong pupil in architecture. Gothic cathedral design frankly avows, through its highly perfected fenestration, an ardent and pagan sun-worship that is diametrically opposed to the spirit of Greek architectural faith. Sunlight is a precious and a sacred thing in gray central Europe where the Gothic builders lived. They framed it in vast windows roof-high and glorified it with rainbow glass. The Gothic style is

adapted to the north. The builders of Lombardy or Provence would have been scandalized at such idolatry of light. Their walls are thick and broad, with windows narrow and infrequent, for with them the sun was a less welcome guest.

As we consider the case for and against geography, we come to the conclusion that it does not explain all the mystery of style. It may give us a clue which is often revealing but not a rule which we can apply indiscriminately and be right a majority of times. Geography is a subtle designer, content with minor touches which give a local charm to building.

To geology we are indebted for the stone and other minerals of architecture. Geology also is responsible for such unusual phenomena as the leaning Tower of Pisa, or the Chicago buildings resting on jacks to prevent their gradual sinking and, it may be added, for the more reliable foundation of the average structure. Until very recently all architectural language, whether native or foreign, took on a certain localism from the nature of the materials which its site afforded. The absence of limestone in New England during the seventeenth century caused the colonists to cover their timbered houses with clapboards and shingles, instead of plastering the wattled space between the beams, as in the half-timbered

Elizabethan homes with which they were familiar.

Physical influences, though subordinate to the rule of man, constantly modify style. The warm climate produces the cloistered porch and the broad patios, while the northern winters turn architecture into a fortress armed against the besieging elements. Physical environment is a critic of style advising radical modifications at times, or now and then adding savory colloquialisms to the language of vision. But man still remains the designer of his architecture.

Style, as a language of line and space, explains why the modes of architecture have traveled beyond national and geographic barriers, have transcended races and even cultures. For language is a tool which any people may borrow and wield for its own purposes. Were it national in character, the architect would be daring indeed if he used any but the speech of his people. Were it geographic wholly, there would be a language for every latitude and weather. Were it connected with the genius of a particular race, no other peoples could share it. Above all, were it the possession of a single artist-inventor, it could hardly be enjoyed by others who had not learned its signs and symbols.

More may be said in support of architectural language being native to a single period in his-

tory, to a single social or religious institution. Assuredly, the Gothic of to-day is a far different mode of expression from the Gothic of the medieval church and the builders' guilds. That has passed with the scholastic Latin and the life of feudal Europe. The only permanent feature of language is its constant change.

But design language has this great advantage over the spoken and written kind. However old it may become, it is readily re-deciphered and brought back into modern usage. For the priceless records of ancient civilization it is the safest language, because, though it may be forgotten temporarily, the key to its meaning is never lost. The period puts its stamp upon the style but may not monopolize it. Elizabethan English is forever gone, but not so the English language. Thus it is with the historic styles of architecture. They still survive, though the manners and methods of the great designers of antiquity can never be duplicated.

Styles persist, because they are not dead languages, but are constantly renewing themselves through present usage and invention. No architectural style will perish until we cease to design creatively in its forms. Our architectural past furnishes us not with models for us to weakly imitate, but with a colorful and poetic vocabulary for original composition.

VII

PURE ART

Design

In the Metropolitan Museum of Art in New York City there stands opposite the main entrance a group of horses done in bronze by an American sculptor. The title of the work is "The Mares of Diomedes." The wild and savage aspect of the animals recalls the grim Greek legend of the man-devouring mares. The fact that the modeling is modern, not Greek, in no way detracts from the excellence of the title. The story is told—and it may have no more foundation than most gossip—that the sculptor of this group attended a dinner and was placed beside a lady whom he had not met before. She told him of her admiration for his "Mares of Diomedes." The sculptor denied ever having executed such a group or ever having heard of the Greek legend of flesh-eating mares! His mystified partner described the bronze in minute detail and insisted it was signed by both his name and his manner. "Oh, that's just a study of western horses I did one summer. The Museum must have christened them 'The Mares of Diomedes' for I never heard of the name!"

The story illustrates how detached an interest the artist has in his work. Most art is abstract, not in the sense of ignoring the objects it represents, but because it looks at them in terms of line and plane, of repeated rhythms and accents. What these rhythms will be depends, of course, on the nature of the model, whether it be a group of running horses, a human being, or a building. But the subject matter ceases to be horses, human beings, or a specific building when the artist looks at it, and it is transmuted into patterns of intersecting planes, of flowing lines, of light and shade, of color and texture. If you were to ask a painter suddenly what he was painting, he might reply vaguely, "green," or some other color. Your own practical nature may identify this patch of color with a tree or a field or some other object of the familiar world of judgment and action. To the artist this green bit of color signifies nothing but a tonal and spacial relation in an abstract and meaningless, yet unified and logical design.

In a sense the artist never draws or paints or models a portrait. He is not interested in his sitters as persons, but as new shapes, new combinations of curving surface and blending color. Or he works with some elusive problem of light, perhaps reflected upward in a curious way so that the eyes and nose are without shadow. The

person whose name he knows and whose behavior is so characteristic, he has forgotten. He is studying the variations of a theme without words in three dimensions.

Art is as impersonal as science, as detached and disinterested. The great difference between the artist and his fellows is that he has the gift of seeing with his visual eye whereas the layman sees with his mind's eye. The visual experience of the artist is quite devoid of practical association, the objects before him are only forms and colors. To the layman everything seen denotes some practical experience. He sees flowers, birds, trees, mountains, and because he recognizes them and knows from memory that they are fragrant, melodious, verdant, and blue, there is no need for him really to observe them. A glance suffices, as it does for the reader of this sentence, who is quite unconscious of the letters or even of the individual words. As the artist is not a reader of signals but an actual observer, he will see far more and see first hand and not from memory.

Of all the arts, sculpture is closest to architecture. Both are arts of three dimensional form. Both interpret through the subtle relationship between blending planes, bold angles of intersection, dancing lines poised for the moment

in static equilibrium. Texture and color are beautiful graces to whom we gladly yield our hearts. They give feminine beauty to architecture and sculpture. But the unique character of both arts is spaciality. They are the arts of surface and mass.

While sculpture and architecture start from a definite subject matter, which may be a human body or a cathedral, once that subject matter has set the problem, the solution becomes an entirely abstract harmonizing and contrasting of forms. As pure art, architecture transcends its practical purpose, its mathematical structure, the perplexities of construction, or its sensuous materials, and dwells in the rarefied atmosphere of geometric solids, of intricate configuration. The practical considerations are not forgotten; they are merely the start for a process whose end-factor is form. Architectural design is the Platonic form which sheds reality on the concrete object.

At this point it is well to guard against misunderstanding. Architecture is both the most concrete and practical of the arts and the most abstract. Buildings are never airy conceits except in poetry. They are tools serving a practical function, composed of the hardest and most enduring of substances. The particular design is always cut out in the living stone. The abstrac-

tion is the conception in the mind of the artist. It is derived from grasping and synthesizing the varied and competing concrete factors.

The practice of dissecting architecture into its parts and distilling design into an immaterial substance of only logical content may be defended only for purposes of study and investigation. The method of analysis always incurs the danger that we may not be able to get the parts together again. Spacial form may become the disembodied soul of architecture doomed to a restless wandering existence. All life vanishes from the organism dissected into its delicately adjusted parts, but violent as this process is, it brings insight and understanding obtainable in no other way.

The architect's task is to solve and resolve into a unified work many problems grouped under the various heads of function, structure, construction, materials, and design. The fluxing agent which brings the others into harmony is the creative art of design. Imagination bridges the gaps that separate the disparate parts. A great building is held together, not by the strength of materials or the genius of engineering, but by the sheer power of imagination.

In architecture, imagination is held in rigorous rational control. It is rarely free to indulge in fancy. The creative ability to give bounding

planes to space involves a type of logic that is of the same order as that of mathematics and philosophy. Herein lies the austerity and rigor of architecture. It is the artistic expression of pure reason.

Not that architecture frequently reaches such rational heights. This only occurs in the more monumental examples of the building art. Often architecture is fanciful or playful. The picturesque touch here and there, the whimsical use of a bit of ornament or of an unexpected material, humanize architecture and endow it with sparkling mirth and fantasy.

The personalities of materials can be portrayed to best advantage in the small building, whereas in the large one they are like people lost in a crowd. In the wayside cottage, the architect may be very intimate and charming. Here the designer has his holiday making dignified oaken beams quaintly decorate the small living room, or turning the solid granite into dainty stepping stones that lead to the doorway or flag the porch with a zigzag random pattern. He pulls the roof down over the ears of the little mansion so that its windows peek out from under the eaves. Architecture may be graceful and domestic as well as dignified and monumental.

Even the greater examples of architecture are not without their bits of humor. The grimaces

of gargoyles give a touch of satire to the stern exterior of Notre Dame de Paris. If the humor is a bit sinister and fearsome, so were the conceits of the time. In Gothic art, the stateliest column may have an amusing grotesque carved in its capital. Gothic ornament fairly swarms with little figures caricaturing man and beast in the most comic spirit. Architecture has its humor and its lighter moods as do those who create it.

What is meant by the word *design* as applied to architecture? A design is a group of parts brought into rhythmic relation. The essence of pattern or design in art is a theme repeated or varied. The rhythm comes from the theme recurring at regular intervals of time or space. Such a rhythmic pattern is the peristyle or porch of columns about the Greek temple, or the ribbed vaulting repeated in each bay over a Gothic cathedral nave.

The simplest rhythm occurs in a symmetrical figure where the same theme is balanced or contrasted in reverse form on either side of an axis. An arcade is an example of the continuous rhythm. In architecture the pattern is characteristically composed of planes and solids, though line is used hardly less often, and sometimes color, too. The twin towers of the cathedral, or its procession of clustered columns mounting to

the ceiling, are two instances of a theme repeated, once in the first case, and many times in the second.

The unifying element in architectural design is its mass. Architecture deals not with planes but with bounding planes. It is never a matter of elevations, but of solids seen in perspective. The third dimension gives architecture, as it does sculpture, its roundness or depth. For this reason all architectural drawings are mere anatomical diagrams. The model, in spite of its miniature size, prophesies the future building more accurately than the rendered drawing. Study it through a pinhole to compensate for its dwarfed scale, and you may see the aspect of the finished building. The model faithfully shows the mass and fortunately obscures the lesser detail.

By mass is meant the surfaces of the building which enclose it as if it were carved from a solid monolith. Inversely, mass, by a free extension of its meaning, may be applied to the bounding surfaces of an interior hall or chamber. The word mass is not wholly satisfactory, for besides denoting a solid which displaces so much air and presents a certain contour to the eye, it also has the connotation of weight. The feeling of weight adequately sustained is often experienced in looking at architecture, but this is not an immediate æsthetic quality.

Two words, scale and proportion, are most constantly in the architect's mouth as he makes his studies for a building. They mean exactly the same thing, but that meaning is not easy to state simply. All measurement is a kind of comparison or analogy. Boston is near in comparison with Berlin, but for the New Yorker neither is near in comparison with the Grand Central Terminal. Length is measured by comparison with an arbitrary unit such as a foot or a meter. Thus a hundred-foot distance has a ratio of a hundred to one with the foot measure. Square surface is measured by two ratios taken at right angles to each other. Similarly cubage or mass is measured by three ratios taken at right angles to each other. In any case size is judged by an exact comparison or ratio with a familiar unit.

A standard unit of measure has its merits for barter and trade—as it also has for architectural construction. But it is feasible to measure the size of an object in terms of itself without recourse to an external unit. The height is so many times the base, or the plane of the façade is two and a half times that of the side, or the cubage of the left wing is similar to that of the right. Proportion or scale in architecture may be best understood as the practice of measuring a building in terms of its parts. Thus the scale for different buildings will vary. This does not lead

to confusion because the architect can always gauge the particular scale by the height of a man.

One part of a building will do as well as another for a measure. The main entrance, for example, may be used to estimate the height of the structure, or the windows, or even the courses of stone. The eye seizes on these serviceable units unconsciously. The Greeks usually employed as their module or measure the half diameter of a column measured immediately above its base, which was divided into thirty parts. All the parts of a classic order are proportional to this module. In a modern building the stories do very well for a measure unless there are too many of them for the eye to estimate!

In architecture the proportion or ratio may be between one line and another, or one plane and a second, or one mass and a greater or similar one. Architectural composition is a study in linear, square and cubic ratios. It is a rich pattern of spacial analogies. A window or a buttress that is too large dwarfs all the rest. The porch or tower that is too small is lost or appears trivial. In architecture at its best, this relationship of part with part extends from the mass to its smallest unit, making the whole a symphony.

Each architectural style has its own rhythm or oft-repeated ratio. This is its characteristic

measure by which recognition is instantaneous—the *leitmotif* of the opera of style and space. Take the English and the French cathedral, for instance. Both are Gothic, but how different they appear! The ratio of horizontal to vertical is one clue to the disparity. In English cathedrals the horizontal is nearly equal to the vertical. They are low and long and wide. In France the vertical is much greater than the horizontal. French cathedrals are lofty and short. Contrast the daring height of Beauvais with the conservative vault of Salisbury. This general difference is carried out in the detail as well. The two ratios largely account for the striking difference, although monastic and other local influences also intensify the contrast.

Not only does each style or variant of a style have its own rhythm or proportion but so does each building. In New York the disparity of scale between structures side by side does more harm æsthetically than the dissimilarity of style. The latter may produce a not unpleasing variety but the monstrous dwarfing of one architectural work by another deforms the whole city. Of all such monstrosities the most ironic is the sight of churches, whose steeples should rise above the carnal world, far overshadowed by some worldly pile.

In drawing plans the architect always has an

established scale, usually that of a quarter of an inch to a foot. Besides the practical benefit of being able to transfer at will any measurement to the actual scale forty-eight times as large, this established scale helps him to design in proportion. He can compare both the relative size of parts and the absolute linear size. Years of thinking spacially give him a sense of proportion as delicately attuned as the trained musician's ear. He has but to glance at a plan to judge the harmony of its parts.

Very often, even in ancient times, architects have employed coördinate paper ruled in squares of some convenient size, such as an eighth of an inch, for plotting plans, in order to sharpen their sense of comparative size. If the parts of the design are laid out a certain number of squares in each direction, each part becomes mathematically proportional to every other. With a little pains these proportions may be controlled to suit the artist's purpose. For the musical scale on which he plays runs from small to large and may be played in any of the three-dimensional keys.

Since architectural surfaces are commonly rectilinear combinations of horizontal and vertical lines, the diagonal will always lay off any base and side in similar proportion. A good many monuments of architecture have been studied in this way and the evidence seems to

show that either consciously or through the precision of the eye, designers have long followed this method. Any one who has had to reduce or enlarge a picture for printing has made practical use of the elements of this principle. All that is required is to draw one diagonal across the picture and from any point on this line within or without the picture according to the size desired, draw a line parallel to the base and another parallel to the side. The new rectangle will always be proportional to the original picture and so will indicate the ratio by which it will enlarge or reduce. By this method all the parts of a design may be brought into proportion.

One of the most ambiguous terms in all the architectural catalogue—which has its share of dark sayings—is the phrase "applied ornament". The phrase suggests some artistic appurtenance removable at will like the frame of a picture. Ornament correctly used is never applied in this sense. It is an integral though not necessarily a structural part of a building. It furnishes the grace notes and runs of the spacial design. Because it but completes the broad intention of the architect's conception, it is in no sense superfluous or negligible. Just such final touches bring the composition to its full development and emphasize its inner harmonies.

But ornament may be rightly spoken of as applied because it is always secondary to the dominant rhythm of the mass and its blending planes. It is a refinement, not a major feature. Architecture would have a rough beauty without this detail, but it would not be finished and perfected. Because ornament deals with essential minutiæ, overemphasis reduces it to ostentation. When used with restraint it is a sign of æsthetic good manners, but when lavishly piled on it bespeaks vulgarity.

Architectural ornament is a decorative branch of sculpture. For architecture and sculpture differ chiefly in their contrasted subject matter. Sculpture concentrates its attention primarily on the human body and the forms of animals. Ornament draws no lines between the animate and inanimate. Any objects that lend themselves to some degree of conventionalization will do. A mythical beast or plant is as serviceable as one in good biological standing. A discarded bit of armor, fruit, creatures of land, sea, or air, foliage, or geometric forms may singly or in combination appeal to the eye of the sculptor of ornament.

The architect uses ornament to accent and enliven his design. In the best work, ornament is concentrated, not lavished over the whole face of the building, though there are not a few ex-

ceptions to this rule. Ornamental enrichment serves to call attention to the principal features of a building and to direct the observer to what is important. Unadorned surfaces the eye takes in at a sweep, but on the sculptured surfaces it lingers with curiosity and admiration.

One might urge quite soberly that architecture had nothing to do with solid masonry and steel, but was the art of molding dancing light, immaterial shades and inconstant shadows; that it was a fantasy conceived in a medium as airy as the stuff of dreams; that its beauty was as transient and evanescent as that of music. For the architect's means of expressing his design are light, shade and shadow. The last two are by no means the same, technically speaking. Shade is the dark tone of a plane turned away from light, and shadow is the dark tone cast on a light plane by the intervention of another solid.

Light, shade, and shadow, for all their intangibility, are the elements that give solidity and massiveness to architecture. A building that is so lit that it casts no shadows and has no shades, flattens into a painted screen floating unconvincingly in one plane. Much of the mystery of the Taj Mahal may be rationally explained by the absence of shades and shadows at many times of day. The only solid elements in a building are its shades and shadows! Our only clue to

the third dimension is read through the dark reveals of doorways or receding walls turned away from the light.

The flatness of the work of the Italian Primitives is not so much due to their ignorance of perspective as to the fact that their figures, like the later witches of Salem, cast no shadows. Had Cotton Mather only known it, there is far more magic in shadows than in the absence of shadows. They not only silhouette the architect's finely traced design, but they clothe it in an atmosphere of poetry and wonder, softening the hard contours and deftly transforming the bleak planes. Rob architecture of its shadows, and, ironically enough, its mystery and romance together with its massiveness and stability, fade away.

Shade and shadow also bestow on architecture its mobility. One never sees the same building at two different times in a day. The light and shadow are forever shifting, giving to the design the movement of life. Here is the secret of the constantly changing rhythm of architecture. No building is static. Architecture is a fusion of permanence and change. Without the ever moving quality of light and shadow, the greatest conception would become monotonous in time. As it is, the architect but sets the themes and light plays the variations in infinite series.

The architect studies the casting of shadows as a mathematical science so that he can predict exactly how the cunning sun will alter his design. A chief function of ornament is shadow casting. A carved wreath of foliage will shade a window as deeply as any verdure of nature. The classic moldings, the cyma, torus, fillet, and the others, are but devices for spinning thin horizontal threads of shadow across the surface of a building. The aris, fluting, and shallow break or offset, make vertical threads.

Texture and color are also largely properties of light. We need not think of architecture as a Quaker art of white and gray. Shadows are blue and purple. The high lights are golden and brown. In place of solid surfaces of color, the builder delights in a texture that mixes hues and light and dark as does the painter on his palette. The play of light brings out the rich range of color in materials. Though architecture is rarely gaudy or garish, it is by no means somber or monochrome. Large masses require a subtler use of color than does the canvas.

From the discussion of so tenuous a thing as light, it is well to turn for a moment to consider the influence of structure and construction on design. Engineering may be said to be of two kinds, practical and æsthetic. It is æsthetic engineering that plays the major rôle in design. It

deals not with inner stresses but with appearances. Admittedly it is superficial. Its formulæ are an open scandal. But it serves the useful purpose of making a building look solid.

Inevitably certain impressions recalled from practical experience come to mind as one views a work of architecture. We feel a certain satisfaction that columns should bear their loads with ease and beams labor without flexing, that a tall building should rest solidly on its base. We have some sense of weight and stress in a structure, though this is sure to be of the vaguest sort if not trained by some knowledge of engineering. The aims of æsthetic engineering are simply to satisfy this sense for structure which we all feel to some extent. If a formal gesture will meet the need, so much the better. The practical engineer has already taken care of the actual stresses. The designer may make a window look solid enough to bear a heavy wall of masonry above. He may place a row of stores with plate glass windows under a soaring tower whose top is scarcely visible from the street. But if he adroitly handles the composition, the fragile glass will serve as well as stancher material to give the impression of an adequate base. A slender band of brick will satisfy the eye that the lines of force on the façade are carried adequately, though the hidden column is placed elsewhere

and the brick is but a ribbon of masonry supported at each floor on an angle of steel.

The old builders knew all about æsthetic engineering, though Ruskin and his followers did not. A pilaster a few inches thick carries a heavy groin vault, so far as the eye can judge, as well as the most monumental pier. To suit the caprice of the eye, a dome must be made in two shells, an inner one whose section is a round arch and an outer one modeled on the pointed arch. Were not this concession made the inner one would look too high and the outer one would be well nigh invisible, or at best, unimpressive. The window must be arched with heavy voussoirs though they be but a facing a few inches thick. A lintel must appear deep and strong though a hidden arch carries the load.

Are these all knavish tricks on the part of the architect? Should he be excommunicated from the fellowship of artists for immorality? A literal-minded past generation would have voted yea. To-day we are looking at this particular matter more scientifically. Design and engineering are separate professions, though they may chance to be practiced by the same person; and each has its own code of ethics to which it adheres with as much constancy as one may ask of human flesh. Sincerity in the art of design is simply good form; in engineering it is safe pro-

vision for the accurately computed stresses. If the two codes coincide on a few articles of faith, they diverge on more.

As far as æsthetic engineering is concerned a good strong shade or shadow in the right place will serve to hold up a building as well as slender steel. There is no possible immoral implication in this structural shadow. For patterns and designs have little weight and may be supported by a strong shadow as well as by anything else. The brick and terra cotta which may chance to be the medium of the design are another matter entirely, to be handled by sound engineering principles.

The *art moderne* in architecture, though still in the tentative experimental stage, illustrates many of the principles which have been under discussion. This new architecture is closely related to the new spirit in the decorative arts which first commanded serious attention at the Paris exposition of 1925, and has since been carried further. They may, accordingly, be considered together as a serious attempt to develop a new style for the use of architectural design.

The immediate movement which prepared the way for this fresh thinking was cubism in painting and sculpture, but the source of these new spacial concepts was the art of Japan and China which acted as a powerful stimulus to western

artists. Cubism was more an educational program than a new art. It taught far more than it produced. For it introduced a new science, the geometry of art. Painters, sculptors, architects and decorators began to study the dynamic properties of solids. They became engrossed in the outer planes which limited the cubage or displacement. Analyzing far eastern art in terms of the properties of solid figures, they made startling discoveries concerning the importance of mass or solidity in design. Thus from a union of eastern and western thought sprang a new mode of artistic expression.

The first thing that strikes the experimenter in this novel form is its complete break with the ritual art of the west. Hardly a word of the old vocabularies of form remains. A few Greek words taken mostly from the archaic period, and a generous admixture of Egyptian terms learned from the newly opened tombs of the ancient kings as well as from a revived interest in Egyptian sculpture, and that is about all that comes from the western tradition. The rest is new to the west.

The *art moderne* concentrates its main attention on the decorative quality of planes and solids. Line is subordinated to mass. Thus it achieves its characteristic architectural quality. Here is a formal mode of expression well suited

to the architectural problem of bounding space. The relation of every opposing plane receives perspective study. Angles of intersection form the strong lines of accent. The teachings of cubism are everywhere apparent. The *art moderne* is supremely intellectual and geometrical.

The old architectural preoccupation with light and shade led to the development of a major means of expression. Panels of glazed light are introduced and light is reflected from parallel and oblique planes. Nature's chance use of shadow is controlled for stenciling the artist's own chosen patterns. The shattering glare of naked light is banished for the more artful effect of rays thrown from shielded sources. This new lighting reveals the receding planes and plots their sharp contours. Here is a solid art, in which sheer volume becomes an expressive property.

The excitement over the new geometric art at first gave color a subordinate position. Grays and pastel shades dominated with an occasional exclamation in bright flat hues. Possibly this rigorous thinking wants no color competition to interfere with the clear logic of the art. But as concepts become more familiar, the avoidance of color may disappear, as it already has in the work of some individual artists. For the light and shade which is so important to the decorative

effects of these new artists can as eloquently be stated in color value as in monotone.

Its indifference to materials is another sign that this architecture is a highly intellectualized form of the art. The exterior of buildings is a smooth textureless white surface in many cases. Wood is painted or lacquered. Metals are so employed that the eye cannot tell whether they are rolled in sheets, cast, or stamped to form. No mark of the hammer mars their smoothness. Texture appears only as a conventional ribbing or machined surface.

But the most striking feature is the complete dominance of form and the complete disregard of structure and construction as well as of materials. An original and daring interpretation of function replaces the traditional expression. Structure is concealed beneath a solid geometric exterior. The separate rooms of a house are piled together like so many boxes or cubes, perhaps about a circular stair. Walls and floors might be pasteboard or steel plate for all the evidence they betray of beams and columns. The furniture is consistently geometric, completely hiding the dowels and mortised joints familiar in other work.

This is the tendency of architectural design carried to a logical climax. Form and mass, the drama of colliding planes of concave, convex and

warped surfaces—this is the rarefied essence of architecture without its usual alloys. Freed from the practical and incidental appendages, architecture becomes pure art. It is the abstract harmonious ratio between solid figures. It turns out to be the darling of the mathematical artist, of the creative logician.

That cold logic and geometry should be capable of such fantasy, such shadow play, such poignant sense for line, hardly seems credible. The paradox can only be explained in the baffling nature of a human artist. His Towers of Babel rise from the earth, their airy masonry reaches to the sky. They are at once the symbols of his highest æsthetic achievements and the mundane tools by which he consummates his labors. Architecture is the most practical and impure of arts and at the same time the most abstract and pure creation of the artist's power.

This romantic world loves fiction more than science. It has built up a myth that the artist is irrational, creating by the fluxing heat of his own emotion. Because he reasons by a logic that has a spacial symbolism other than words, his conceptions are supposed to be the revelation of intuition. But intuitions, those sudden illuminations, are a part of all thinking—artistic, scientific, or practical. The scientist takes the well-known inductive leap whenever he passes from

his particular data to a generalization that comes to him suddenly like the revelations of the prophets. All productive thinking follows this pattern, whether it be mathematical or artistic.

Nor do these flashes in the night suffice. The artist is a thinker who analyzes his material rigorously and wrestles long with his problems of design. The dark places between sudden intuitions must be filled in by arduous reflection and patient experimentation. When a trial plan or sketch has been completed, it must be tested and criticized as unsparingly as any other hypothesis. It may take generations to test fully the truth and excellence of a building, and many alterations may be necessary during the centuries of its trial.

For all its imaginative and sensuous delights, architecture is admittedly a philosophic art. As a pure art it is highly abstract, and the theory of its design is full of the abstruse mathematics of solid bodies. Its plans involve the ability to grasp the full functional significance of complicated social institutions. The architect must have the prime qualification of the philosopher, the ability to see the principles that underlie the problem, the whole clearly outlined distinct from its innumerable and confusing array of parts.

To plan is to think. To design is to reason. Emotion is an essential factor in any art but it leads to lunacy, not creation, unless it is guided by reason. Architecture is emotion suspended in perfect equipoise by thought. It is æsthetic contemplation embodied in art. It is passion stilled by meditation and reflection. Architecture is philosophy made art.

VIII

EXPERIMENTAL VERITY

Construction

The builders of the Tower of Babel tried a great experiment which failed. But such is the nature of experimentation that failure is no less informing than success. The negative result which they achieved is of the greatest interest in the history of experimental science, of which it marks the first chapter according to our present records. Here is a grand scientific hypothesis which, had it proved true, would have enabled man to unite heaven and earth, a project to which he has devoted more than one millennium, though never after did he try so ingenious an experimental method. Too often in later and better informed times he failed to subject his imaginings to so crucial a test. He preferred faith to questioning.

No doubt the Lord in His wisdom foresaw that, with this method which man had invented of asking Him pertinent questions in such a way that He could not veil his replies in vague sayings, "now nothing will be restrained from them, which they have imagined to do." Perhaps it was the part of divine Providence to

thwart such precocity in the childhood of the human race. Science is so awful an instrument, so vast in power, that it may well be questioned whether mankind is yet mature and sagacious enough to wield it without self-destruction.

Experimental science is the means by which we test the verity of what we have "imagined to do." It is the proving ground of the imagination. Visions are desires which may be fulfilled. Man's practical task in the world is to test his visions and carry out those to which nature will accede. The idle are those who slumber in dreamless sleep. The weak are those who dare not trust the fragile stuff of the mind's spinning.

Art and science are the great experimental methods. But they are not the same. Science is a lover of facts. It hoards vast quantities of minute and careful observations, never forgetting a single instance. These act on the scientific imagination as a sort of ferment. From them by some intuition or alchemy the scientist derives a law, and lo, the chaos of particular things vanishes and they become one. He ascends from earthborn facts to lofty concepts, to the cosmic generalizations of the Olympians above.

Art is science turned backwards. It is deductive, whereas science is inductive. It begins with a vision suggested by nature, or derived from the mind's own shadowy chambers, and strives to

embody this in a tangible form. It is a concept made concrete. The most abstract art approaches the Platonic formula of the universal in the particular. But usually the artist is content to start with a less ambitious generalization, to state some lesser truth. His creation is always a definite physical object, be it a statue, a pointed spire, or a poem filled with fair thoughts couched in things of sense. The artist stoops to beautify earth, while the scientist's ambition leads him to scale high heaven. The paths of science and art cross but do not coincide.

The results of æsthetic thought are always concrete, those of scientific thought always abstract. The artist embodies a concept, the scientist disembodies it. The typical pattern of art is form of some kind imposed upon matter, that of science form derived from matter. Art and science are our two means of relating things and thoughts.

In art we are concerned with single objects and their uniqueness and diversity. In science we are interested in vast numbers of objects and in their similarity. Art demonstrates the diversity of nature; science asserts its uniformity. Art is qualitative, science quantitative. In art, directly observable physical qualities are revealed for their own sake, in science physical qualities are employed solely for classification. The lan-

guage of art is lines, planes, solids, colors, texture, light, shade, tone, pitch, rhythm, and the other groups of qualities in the time-space continuum accessible to the naked senses. The language of science is mathematics, quantitative analysis, functional description, statistical comparison, and other abstractions. Art is our way of seeing a part of experience in isolation; science a way of grouping it so as to present a broad view. The one is individual, the other general. Because it allows the senses to come into play in their own right, art is emotional, and conversely, because it utilizes the senses merely as tools, science is dispassionate and calm.

The artist's painting is a pattern of color and light, of spacial relation, and sometimes of line. This pattern is the concept which the artist captures and fixes to the canvas. His method may be to record his direct perceptions of nature, one by one as he sees them, thus arriving at a unified concept; or he may begin with a well envisaged picture in his mind's eye which he strives to communicate by means of paint and canvas. In either case, whether working from life or from "memory," he is attempting to represent spacial ideas which are essentially abstract, which are the creation of his own mind, into pictures which are concrete, the creation of his hand.

Here is the central characteristic of all art.

It is a way of passing over the old philosophic chasm between mind and matter, tenuous thought and tangible things, concepts and objects. Science leaps from the things of sense perception to those of abstract thought. Art is a bridge from thought to things. In life it is continually necessary to make this perilous passage. Science and art are the two routes.

Spoken language is nicely compounded of both art and science. In its beginnings it was pure art. It denoted concrete things. It was a list of fair names. The thing stood for the thought. Gradually as language approaches the realm of pure science, man learns to use it more abstractly. The object is forgotten and the word ceases to be a name and becomes a symbol. The generalized word has turned into pure science. The poet and the mathematician stand at opposite poles. When the poet uses language, it is compact wholly of bright objects of sense; a poem can be seen, touched, or heard. The mathematical scientist speaks a sign language that has been distilled to eliminate all reference to particular things.

In the gay company of things, man becomes once more a passionate child of nature. His imagination blazes with a riot of colors and images. His feelings tingle with vitality and he is a bacchant. Art brings back to the race its

youth and early vigor. Art is the only fountain of eternal youth.

But if we, like the aged Cephalus of Plato's *Republic*, desire the calm reason and clear thought of philosophy, it may be that we welcome advancing maturity. The race has hardly learned to follow the path of science away from gusty things to abstract law. Plato lingers until old age overtakes him before he writes his *Laws*. So with us, science has but recently begun to occupy our attention. Mastering feeling and imagination, we have begun to see the world in the light of reason and mathematics. At first the sight appalled us. We stood with frozen hearts like the child looking on death for the first time. But now we are able to welcome science as Cephalus welcomed it, knowing that it will liberate us from our early passions.

The scientist and the artist meet when their respective tasks of discovery and creation have been completed. For then both must seek experimental verification of their work. What they have toiled long to state must be tested ruthlessly and fearlessly. Both have this courage, this devotion to truth. Like the scientist's hypothesis, the work of art is forever undergoing the test of experience. It may fail though many generations have acclaimed it. Time is the judge. Neither science nor art have any hope of im-

mortality should they fail this test that is impersonal and just.

In architecture it is the builder who is the experimentalist. His work must stand the ordeal of centuries. He, with his calloused hands and dusty garb, must subject the architect's plans to the stern trial of embodiment in stone. If the engineer has not computed his stresses rightly, the builder will find the flaw in a beam that bends. If the architect has failed to see the warped planes of his net-like vaults according to the true line of their intersection, the builder will find him out. For steel and stone, no portion of the plan can be dimly visioned or vaguely sketched. The builder will demand all the details drawn to full scale, with measurements plainly indicated. He is a supremely practical person for whom ideas must be made hard and sharp in definition.

All building is of the nature of an experiment. No architect can forecast with absolute certainty how the drawings will appear when carried out in mortar-set materials. The engineer's calculations prophesy an average condition, not an actual one. The distance between theory and practice grows smaller as civilization progresses, but it is always wide enough to hide many uncertainties. These cannot be foreseen but must be resolved by testing through actual experience.

Though his handbooks are full of rules, the engineer is reluctant to trust to the uniformity of materials. A good deal of structural engineering is taken up with making laboratory tests of the properties of materials and establishing the merits of different grades. Concrete is cast and subjected to pressure to determine its crushing point. Steel bars are placed under tension until they reach the limit of their elasticity and fail. But after all this testing is complete, the supreme test is the building itself. The actual process of construction is a more drastic method of verification than any laboratory routine.

More guess work than the designer would like to admit to his trusting client is always involved in proportioning a building. Sometimes a lofty cornice is molded in plaster and hoisted into place high above the level of the street so that the designer can see whether the detail is bold and coarse enough to carry from such distance. On important work, a miniature model to scale is nearly always made. This the designer studies and corrects with the delicate pains of a jeweler. He weighs the masses with his eye and explores the contours of the shadows in changing lights. He photographs it to see whether the mechanical eye of the camera will detect something that has escaped his scrutiny. But the final model by which his design is tested is the building itself,

ascending to the clouds on an airy ladder of steel framework. This may turn out to be a bitter satire of his ideal, an uncouth Frankenstein. Or he may have molded a colossus of supple and stately form.

As the building climbs toward its goal he watches it with astonished wonder. Hardly can he believe that his thought could rival the beanstalk of Jack the Giant Killer. As the architect watches the builder carry out his plan he never outgrows this childlike wonder. The process of transforming the thin white lines of a blueprint into towers of masonry and might is a miracle. The engineer may on occasion move mountains by his faith, but it is the architect who creates them. And when the creation is finished, he looks at them with the awe and reverence that he feels for the mountains of nature.

The builder who actually works the miracle is a practical man of copious common sense and ingenuity. He tolerates the architect as the world does the poet and has a vast respect for the engineer and his mathematical learning. Experimentation is for him as much a part of the precarious routine of existence as adventure is for the mariner or danger for the explorer. While the observer is thinking of the loftiness of the roof, the builder is preparing a hoist to carry up concrete for its construction, thus making

naught of the height. To the architect studying the proportion of his façade, the builder puts the question, How long is it? No metaphysical problem troubles him. He is a master of physical tasks and physical things which he can see and touch.

His practical mind is much occupied with costs. He has a great fondness for tools and labor-saving machinery that will mix his mortar and concrete or raise his girders into place. Of all the trades and manufacturers engaged on the job he has a sympathetic understanding and a shrewd perception of their motives when it comes to bargaining. For materials he may even at off moments be weak enough to betray some æsthetic attachment. He likes a good grade of stone quarried from sound primordial rock and properly seasoned; the color and veining may not be the first consideration with him and he may actually prefer color that is monotonously uniform. But he likes sound materials and one need not probe too deeply into the nature of his affection. For the army of workmen on the job his gruff exterior conceals a paternal interest, a sense of human solidarity in corporate endeavor. Such is the man who risks the great adventures in architecture, not infrequently at personal peril.

In the builder the zest for adventure is strong.

The very contract which he signs to complete the work for a certain sum and perhaps within a certain time, is a gamble with fate. Until the work is done he cannot tell whether he will make or lose. He reads the sheets of blueprints, the list of materials, the articles of the specifications. What an assemblage of untried ideas, and ingenious imaginings! He runs a test boring into the earth to see whether it will bear the proposed load. He divides up the blueprints and gives them to scores of manufacturers to find out whether they can make the materials needed and how much these will cost. When his estimate goes in, it is composite of both figures and faith. He stands voucher for the architect's dream.

The great thing in any experiment is to know, and if possible to control, all the factors involved. The progress of engineering has made prophecy a less dubious profession than in ancient times. The prophet reads the future in the mirror of the past. This involves charting experience carefully as it takes place, for at best the mirror transposes things confusingly. That all the factors should be known in advance is more a hope than an attainable goal. The behavior of inorganic substances and mechanical devices is much easier to predict than that of complicated human organisms or organizations. The former

still has its surprises but the latter is ever a mystery, and the builder must deal with both.

The battalions of workers, of which the builder is the commander, are men who have had to wage economic war for what they believed to be just earnings; and between the trades there is always more or less friction and rivalry. But at bottom the carpenter, the mason, the steel worker, and all the other builders find a satisfaction in their labor and fabrication that proves craftsmanship is vigorously alive to-day. The love of bonded materials and workmanlike construction is strong in these men, though the guild has been superseded by the union and the hand tool by the machine. More independent and combative than the servile workman of old, they are still loyal to the goals of coöperative effort. The building attests the pains and skill they mingle with their labor. They meet and conquer the unknown as part of the day's work. The proof of the quality of their toil lies in its accomplishment.

Interest in craftsmanship plays a large part in the appreciation of the fine arts. As artists we take pride in exercising or exhibiting our skill, and as observers we delight to see art that displays a high degree of technique. We even derive a certain pleasure from sheer virtuosity, though this be exploited by one who is more artisan than

artist, one who has little content to convey. Pictures or architectural designs which exhibit virtuosity are akin to the work of the clever mechanic who contrives to assemble an intricate model of a ship within a bottle. The result may not be art, but it nevertheless has interest.

The part that skill plays in all artistic creation may not easily be overestimated. In architecture alone among the arts, this trained power of manipulation of instruments and materials, must be delegated by the artist to others. Except for the work of his pencil and T-square, the modern architect must renounce all cunning of his hands and fingers. The workmen skillfully carve the stone or hammer out the iron according to his design, while he must remain a mere onlooker. He may never spread the soft mortar on its bed with a flat trowel and lay brick on brick. The workman who watches him go about the rising building on his tours of inspection little realizes that in his glances there is less of criticism than of envy. The workman cannot know that this office toiler would like to have hard, useful hands that understood well the art of guiding tools.

In all the arts save architecture, the artist labors with the actual materials of his art. Even words, though they may not soil or callous one's hands, demand a deal of hard practice in their use. And this practice of the writer is

in the ultimate substance of his art. Chinese men of letters have always regarded writing as a kind of graphic art, and so it is, though we substitute a machine for the brush or pen. The writer is a drawer of words and sentences. But the architect draws plans which are neither themselves the stuff of his art nor directly a part of the finished masonry.

In music, skill comes into play in the mastery of an instrument, which, after all, is not different in kind from the mastery of a workman's tool. The painter is concerned with handling brushes, pigments and canvas; the sculptor is plastered with clay or covered with the dust of marble. All the artists except the architect may leave the impress of their own hands upon their work. His art must be touched by other hands. If the architect is the loser, the builder and his workmen are the gainers. The skill and power over formless matter which is so vital a part of art is theirs.

The modern architect leaning over his drafting board often recalls wistfully the master-builder of antiquity who was three persons in one, architect, engineer and workman. This builder-architect needed not to think out his whole design full-fledged. It was enough if he saw a part and conceived the rest somewhat dimly. The modern architect must produce a

matured and developed plan from his brain as Jove did Minerva, a godlike procedure exceedingly difficult for man to copy. The old master-builder appears to have been no great hand at drawing plans. A sketch or two sufficed. These might be supplemented by a model. But beyond this he trusted to the operations of creative evolution. One step suggested the next. He planned the walls that would fit his foundation, the vaulting that would rest securely on his walls. If he had some architectonic conception of the whole, much of it was still hypothetical.

The ancient form of the experimental method had certain vast advantages, but it did not enable the architect to predict. What he started with sound Romanesque walls might finally be crowned with a Gothic ribbed vault. He controlled the present, not the future, as does his modern follower. His work progressed slowly, stone by stone. Often centuries were built into the successive courses. Several generations of builders might succeed each other in the planning and control of the work. Small wonder if the design and principles of construction spoke a babel of tongues from many periods.

The great advantage in this testing of part by part and formulating the problem step by step lay in the possibility of gleaning some clue, some answer to the unsolved problems ahead. Each

stone laid was an experiment that helped to state the final goal. The builder might be working to an extent blindly, but he was well led. To be sure, future generations which inherited the uncompleted task might have to destroy some of the old work to make way for the new, might have to waste years of patient toil; but these were more careless times, more prodigal of labor and intelligence.

In these pre-engineering, pre-scientific centuries materials arbitrarily enforced their will on man or whispered intimately to the builder the character of their wishes. The designer was limited by what he could build. He pondered long before he risked a vault of more than twenty-five or thirty feet in span. The local stone must do, because roads to distant quarries were rutted and impassable. As a result he found himself more builder than architect, and more workman than builder.

Because of his limitations he perforce relied on the traditions of his craft more than on his own initiative. He followed the ritual of style and practice with simple faith and dared not venture very far into the unknown. Architectural experiments might for centuries be simply shore-bound voyaging. Yet taken as a whole the record which he has left is one of daring, not of timidity. While the churchmen for whom he

built, timorously adhered to old doctrines, he, high above their heads, was throwing his centering over the altar to support a ceiling as heretical as the beliefs of Galileo.

Only occasionally did he inadvertently emulate Samson in toppling the temple down on the heads of the faithful believers below. His laboratory training guided his guesses so well that Gothic architecture is still the wonder of the modern engineer, though at times its expedients provoke his appreciative mirth. Now and then a flying buttress, sprung too high to take the thrust from the vault ribs, falls of its own weight, while the unsupported vault remains disposing of its thrust in a manner that would have been incomprehensible to the medieval builder. But this does not happen often. If he knew nothing of theory, he had enough of practical experience to make up for the lack.

The whole matter of design and ornament was far easier for the medieval builder than it is for the modern architect. He could gaze up at the uncut block above the column and its unhewn shape might suggest to him some unique device to carve into a decorative capital. As he visited the darkened building after working hours and looked up into the sinister shadows among the scaffolding, he saw the image of grotesque and fearful monsters which he might carve into

water spouts or ornaments. His design displays surety of touch and appropriateness no matter how fevered his imagination might become with images of the other world, because he devised it in the place and for the place it was to occupy.

Sometimes, no doubt, the workmen copied an artist's cartoon, but more often they themselves executed drawing and sculpture simultaneously, aided only by chisel and mallet. Here is the secret of medieval and, to a lesser extent, of all ancient work. There was not just one experimentalist, some distant architect; every workman both designed and proved his design in the stone. The result amply attests the verity of the method. Gothic buildings have infinite variety and individuality. They represent experiments that succeeded through the coördinated labor of a whole corps of investigators.

Herein lies the originality of any art. However tried the medium or familiar the vernacular of the style, the finished product is the result of a whole progression of experiments. If these are not done on the canvas or in the stone, they are done in sketches, and tracing laid on tracing. Sometimes, with a great artist, a Leonardo or a Michelangelo—or, to add a man of our own day, a Rodin—more than half their work seems futile experimentation. Critics and public lament that

the work was not finished, failing utterly to see the similarity of art and science in laboratory technique. The artist values his baffling failures hardly less than his successes. They are his teachers, his guides to new dreams of the imagination.

Frequently in modern building contracts a clause provides that the final payment to the builder shall not be made until a year after the formal completion of the building, so that he will be financially responsible for any defects or omissions which may appear in occupancy. But the building continues to be tested long after the builder receives a final reckoning. The owner, the occupants, and the public use and test the values of the building perhaps for centuries to come. Thus the public participates in the constant laboratory research for better architecture. Very often an edifice with grave defects will survive these thoroughgoing tests. It may be so beautiful that beholders and users alike forget its inconvenience, or it may preserve a bit of history, too precious to the race to be lightly destroyed. Curiously enough the purely functional values of a building are most transient. Usage changes rapidly and buildings that are only tools and nothing more are quickly discarded.

The history of architecture might be interpreted as the experimental development of the

science or art of building. But sometimes far other problems than the mere construction absorbed the attention of those who built. However, if the interpretation is made broad enough to cover all phases of the experimentation—in construction, design, adaptation to function and climate, structural engineering—such an architectural history might be an epic of the scientific method of verification, of establishing truth by ordeal. This history might well be written about the builder alone. Nor would its pages be lacking in stories of the kind of courage which does not shrink from subjecting its most precious dreams to the crushing weight of stone.

A great problem with which builders of different ages have wrestled is that of the dome. It is but one of many daring devices tried for spanning vast wells of empty space. But because this man-made imitation of the bowl of heaven is so impressive to the eye, because it appears to float cloudlike above the head of the observer, hardly resting on the encircling walls, it may be chosen from all the other devices by which the builder has circumvented gravity.

The Pantheon at Rome was one of the great wonders of the classic world. The main rotunda goes back to the reign of the Emperor Hadrian in the year 120 A.D. The imperial architect-builder is forgotten. But possibly for so

marvelous a work no one man deserves the single credit, or deserves the high honor of having it stand through the ages as his memorial. The mighty dome is 142 feet, 6 inches in diameter and soars above the marble floor the same distance vertically. In the center of the dome is a great unglazed eye 27 feet across. This is the sole means of lighting an interior so vast that man is dwarfed to insignificance by his own work. The luminous sky itself is thus made a part of the structure by the ambitious designer. This grandeur borrowed from heaven endows the interior with all the majesty and solemnity of Imperial Rome. How was this vast well, 142 feet across, spanned? Not without the divine help of Jupiter's blue mantle! But this bit of sky is only the keystone to man's work. The material of the dome is brick and its enormous weight is relieved by deep coffers or panels let into the dome in four steps. The outer face of the dome starts with a flight of giant steps and then flattens into a spherical curve. Once this dome was covered with bronze plated with gold, and it must then have shone like the surface of the sun. The magnitude of the work and the cost of the materials shows what vast resources the architect had at his command. How this greatest of Roman builders accomplished his titanic work is a secret that has perished with him. It

ranks with the highest achievements of a people who, though they bowed to the Greeks as designers, still are recognized as among the supreme builders of all time.

Building requires all the practical virtues in which the Romans excelled—courage, ingenuity, common sense, organization, and not enough imagination to be fearful of the future, of the unknown. They never had the speculative genius of the great artist or scientist, but they never were too conservative or too timid to try any enterprise which occasion might thrust upon their attention. Building, construction on a vast scale, gave them an appropriate outlet for their exhaustless energy, and the builder symbolizes their accomplishment in empire making, their unique ability to experiment profitably and successfully.

The second great dome of the ancient world is not a temple to the pagan divinities, a Pantheon, but a church dedicated to the divine wisdom of the Christian God who had already conquered Rome, or been conquered by Rome and Greece, as a student of St. Augustine might conclude. Santa Sophia is the great monument of the eastern empire as the Pantheon is of the western one. It is symbolic of the effect of Oriental religion on the Roman Empire. The architect-builders of this domed church, com-

missioned by the emperor Justinian in 532, were Anthemius of Tralles and Isodorus of Miletus—possibly geniuses of the Greek and Jewish races. The Roman emperor may have contributed the vast wealth, the Greek the imposing plan and the Jew the capacity to administer so tremendous a project. Certainly some such division would have been appropriate in a Christian church of the empire. For the church of the sixth century was a fusion of Hebrew, Greek, and Roman elements. The Jew must have been a man of many talents, for it is certain some eastern artist had a directing hand in the rich design of this oriental masterpiece of architecture.

Santa Sophia is not one dome but a whole symphony of domes and semidomes, the great central one buoyantly poised above a ring of light, composed of forty windows. This dome is 107 feet in diameter, much smaller than that of the Pantheon, but it rises to the far greater height of 180 feet above the floor, and at either end of the nave an imposing semidome leads the eye up to the four mighty arches on which the central hemisphere rests. But the most amazing feature of this great central dome is that the builder has had the audacity to set it upon a square base. Circle and square have been united. The means by which the builders worked this miracle are four pendentives which may best be

described as four spherical triangles stood upon their apexes in the four corners to make the transition from square to circle.

The interior, with its columns of rare colored marbles brought from Phrygian, Laconian, Libyan, Celtic, Thessalian, and Bosphorus quarries, together with many taken as spoil from ancient pagan temples, with its walls overlaid with veined marbles and its pendentives and domes encrusted with glittering mosaics now concealed by Moslem piety, is one of the great climaxes which art attains only a few times in each millennium. But the feature that the builder loved above all these costly materials was the pendentive. This Euclidean proposition in spherical geometry so clearly demonstrated to the eye deserved to wear the crown of such a dome. It is pure thought translated into pure art. The builders who tried out the demonstration rank with Ptolemy, Copernicus, Galileo, Columbus—the explorers of the sphere.

To picture the full measure of the builder's triumphs, we must consider two other famous domes. One of these is the first great victory of the renaissance, the other its final triumph and consummation. Brunelleschi's dome over the cathedral at Florence was begun in 1420. Instead of using pendentives, the square crossing is changed to a great octagon that mounts on

arches to form a lofty base for the dome, 180 feet above the floor. The mighty dome which looks down on all Florence, overtopping even Giotto's tower, has a pointed Gothic section and straight octagonal sides, which meet in a beautiful lantern at the top. From the exterior, especially at a distance, the full glory of the dome appears. But the barren and cavernous interior of the cathedral is more to the taste of the small bats that inhabit it than to that of human beings. The dome is a sheer 138 feet, 6 inches from side to opposite side. Tradition has it that Brunelleschi succeeded in building it at this dizzy height without the use of centering or forms to carry the masonry while it was being constructed. He guarded against the tremendous thrust of the great dome's outward pressure by a mighty chain of oaken timbers linked with iron, which he bound around its base.

Architects regard this dome as possibly the most difficult of any ever built. For one reason, it is placed at such an impressive height. For another, its span, greater than St. Peter's and hardly less than the Pantheon, multiplies the difficulty of its erection many times. The period, also, in which it was built knew little about domed construction so that this was an heroic test for a new theory. But the hardest problem of all was the octagonal plan. In a round

dome, each succeeding course of the gradually narrowing masonry is a horizontal arch, locked together and self-supporting as soon as the last stone in the circle is slipped in place. But in the octagonal dome, the straight, unarched sides may fall inward of their own weight as long as the upper portion remains incomplete, though when it is finished the thrust of the dome itself, which in section is an arch, will support it. This is the fact that makes Brunelleschi's having contrived to build his dome without centering so miraculous. But its immense height supports the tradition, for the cost of timbers enough to fill the space below with supports and braces would have been a king's ransom.

Brunelleschi concentrated in one man the capacities of the great designer and the great practical experimenter—a combination of qualities which might have made him an outstanding scientist, had he chosen the path opposite to art. Had he failed in his mighty experiment, there might have been no St. Peter's at Rome, no St. Paul's at London, or indeed no domed national capitol in America. For had the renaissance builder been unable to prove the principle of the dome as a safe hypothesis, it would never have become the crowning and characteristic feature of renaissance style.

The last dome that must be listed among these

memorials to building genius is that of St. Peter's, a colossal pile on which many architects and builders labored for 120 years before it was completed. Half the great artists of the renaissance worked on it. Among them was Bramante, whose plan won first prize in the competition for architect, Raphael, who was an architect as well as painter, Giuliano da Sangallo, Baldassare Peruzzi, Antonio da Sangallo, Michelangelo, who planned and started the great dome, Giacomo della Porta, and Domenico Fontana, the builders who completed it from Michelangelo's models after his death in 1564, Vignola, Carlo Maderna, and Bernini.

We must here confine ourselves to the most important of its builders, Michelangelo. He became the architect of St. Peter's when over seventy years old, but he still had enough vitality to give the building the dominant impress of his personality. His dome, which is the Mecca of Catholic Christendom, ascends to the height of 450 feet and rests on a base that is 250 feet above the floor level. Its diameter is 137 feet, 6 inches. Only the Holy Roman Church which was the inheritor of Imperial Rome could have made a gesture of such majesty on earth.

The dome carries the science of building to still further perfection, taking full advantage of the fruit of past experimentation. Its penden-

tives, instead of appearing to carry the weight down to an impotent point, are truncated, spherical triangles which rest solidly on the diagonal wall below. Brunelleschi's scheme of placing the dome on a high drum could hardly be bettered; but Michelangelo, following Bramante's suggestion, adorned the drum with a band of columns grouped in pairs. To avoid the disappointing interior appearance of the Duomo at Florence, Michelangelo built his dome in two shells, a nearly hemispherical inner one, and a steeper outer one which might be seen better from afar.

Michelangelo's dome is the farthest goal attained by the renaissance. From the top of its lantern the cross looks down on Rome and far beyond her seven hills. It is the justification of the faith of both spiritual and physical builders. However Michelangelo's fame may be diminished through the baroque concessions of his designs, he was a great builder, a tireless investigator, capable both of grand conceptions and of their demonstration in construction.

Why are men builders? Why do they seek to test their visions in hard granite and steel? Perhaps because, as Plato believed, ideas are beautiful to look upon. Art is thought revealed to sense. Would we look upon the fair furniture of the human mind, we gaze on architecture,

painting and sculpture, or listen to flowing music. The builders of domes have left us the images of mighty thoughts.

The builders of the Tower of Babel showed the grandeur of man's intellect striving to mount to heaven. If the test failed, it was because man's highest conceptions never can be adequately embodied in art. This is the tragedy of all art. The problem of translating the idea into a perfect image forever spurs the artist on but forever baffles attainment. The scientist can never fully know his world, the artist can never behold it in its full perfection. Yet both must search and experiment always.

IX

ARCHITECTURAL PERSPECTIVE

Æsthetics

The traveler who makes a hobby of architecture soon learns that to gain an intimate acquaintance with a cathedral is an undertaking involving both leisure and finesse. It is well not to approach a cathedral town by rail or automobile but to travel as a humble wayfarer on foot. Such was the practice of the medieval pilgrims, and the procedure still has many merits to recommend it. One catches sight of the cathedral for the first time at the turn of a dusty road and sees it rising in majestic proportions above the roofs and chimney pots of the town which crowds around its base. There is ample time to pause by the roadside for rest and to take in the contours and proportion of the shrine which is the goal of so many miles of effort. From the distance distracting details are obscured and the eye notes only the splendid height of the towers, the roof, the transept, and the rugged buttresses. What one sees first is not a rich profusion of carved figures on the portal or traceried windows or stained glass, or tiny pinnacles. None of these

details entices the eye from the proportions of the structure itself. The cathedral may be observed in its true perspective.

Strolling toward the town, gradually one part after another detaches itself from the mass. The traveler begins to note the flying buttresses and the placement of the great windows. By now it is safe to hazard a guess as to when the major part of the structure was built. There is opportunity to recall something of the history which went into the making of this link between worldly medieval life and unworldly medieval aspiration. At every bend in the road the mass of the cathedral becomes a new problem in proportion.

As one nears the city wall—for many a cathedral town still has walls—it is easy to reconstruct the mingled feelings of a pilgrim about to enter a strange city. Though he dwelt but a day's journey or two away he was setting foot in a foreign kingdom, the abode of a strange and possibly hostile people. His only bond with them was that of religion, his safeguard the dark outlines of the cathedral which looked down sternly upon the battlements of the city gate.

When one enters the narrow winding streets of the town, the scene which meets the eye is perhaps the same, but for minor changes, as that which the fourteenth century pilgrim saw. Old houses lean out above the cobbled street.

The cathedral, fully visible from afar, has disappeared; and ahead is a maze of narrow byways. But the traveler can be sure that the main highway will lead in its direction; and in a few minutes' walk a momentary glimpse of a single tower, filling the opening left by an intersecting lane, rewards his eye. The cathedral may be lost and reappear again several times before he reaches the market square upon which it fronts.

The sudden view of the cathedral from the square is a climax never adequately prepared for in advance. But it is also an anti-climax, for so little of a great cathedral can be seen from the front. It may require weeks of rambling about the city to study the ancient pile from every side and familiarize oneself with all its aspects. Indeed a summer's stay is hardly enough. It must be approached from every side and from the rear, up steep streets that presently turn into steps. A good place from which to examine some particular part is a street café, with a glass of red wine and some medieval author conveniently open upon the table. In learning to judge the merits of various places of refreshment, one imperceptibly begins to acquire an acquaintance with the cathedral, to discern something of its moods, its ancestry, and its rôle in the community.

In the course of daily visits to its cool interior

one has witnessed many a christening and burial. One knows the services. The radiance of the stained glass toward sunset has transfigured the somber gloom. There has been leisure to examine all the bits of carving and to form special preferences among the small manikins and beasts sculptured there. The problems of the vaulting have all been followed through and their adroit or forced solutions appreciated. A particular beggar greets the daily visitor at the door knowing he or she alone is entitled to his patronage. One has even discussed Erasmus, Aquinas and St. Augustine—about the only worthies of the church with whom the traveler has a reading acquaintance—with certain of the holy fathers of the cathedral.

Such intimacies in the course of weeks and months combine to round out somewhat less academic theories of architecture than might be derived from books alone. Moreover this acquaintance expands appreciation considerably beyond the range of a strictly professional interest in the art. The question might be raised as to whether all this is architecture. Certainly it would be difficult to separate such an art from the life it shelters and represents. To try to do so would only produce the abstractions of the usual architectural text.

These essays have been an attempt to follow

this leisurely investigation of architecture which pauses to view it from many prospects. At times our attention may have wandered to things which appear to be other than architecture, but we are dealing with an art which is organically related to all of civilization. In a sense every great monument of architecture is a meeting place of numerous highways and byways. A few of these roads have been explored far enough to secure new vistas and backgrounds. Yet inevitably these glimpses of a single side or picturesque portion have yielded not a complete picture, but fragmentary views, difficult to fit together. It is now time that we regarded architecture in a perspective which will include more than one elevation and give us some conception of its unified character.

In considering architecture as a whole, we immediately discover that here is something vastly different from the mere sum of its parts. The synthesis of diverse and colorful constituents has produced an art that is greater than any or all of them. Nor does it in any way resemble them, though it is nourished and enriched by each. By some miracle of æsthetic metabolism we stand in awe before a new creation. One recalls the Chinese philosopher's words as he pondered on the flowering water lily: "The lotus is more than the mud and water from which it

springs and to which it is resolved; life is more than earth which is its origin and its end." We are dealing with a mystery of organic relation which eludes us entirely when only the parts are seen.

The various elements of which architecture is composed are brought together in æsthetic experience. When we contemplate a building, we are not aware of its different values, but of the unified composition. A sketch of this æsthetic experience, therefore, will serve to give a perspective view of architecture, in which the various parts blend into one harmonious whole.

As a background for this sketch, we may begin with a brief review of experience in general. Though this appears infinitely rich and multiform, we have seen that it is of three characteristic types, practical, scientific, and æsthetic. Practical experience is the means by which we use our world, scientific our method of knowing it, and æsthetic our way of appreciating it. Often in the ebb and flow of existence these three currents become mingled so as to be scarcely separable, and rarely are we conscious of the subtle change from one to another.

The most marked characteristic of practical perception is that through it we see everything in direct relation to ourselves. It discloses a world of which we are the center. All the ob-

jects of this world are things that we can use as tools, or that affect our actions in some way. The observer recognizes a particular building as one where he can buy food, or where he witnessed a play, or which he passes on the way to his office. He has a personal interest in all he notices, and he notices only things in which he has this personal interest.

Since practical perception regards things only as they affect what we are doing or wish to accomplish, it tends to ignore everything that does not have this utilitarian relationship to ourselves. It is a method for reducing the unlimited flow of things to a small list of items which we can conveniently employ in some way. It selects only what seems to be for our private advantage, and allows the rest to pass by unnoticed. A typical example is that of a man walking down some crowded street oblivious to those about him until he meets an acquaintance. The fact that he notices his friend shows that his perception has been sorting and rejecting the impressions made by people who passed until, out of thousands, the particular man with whom he had a connection came in sight. Practical perception is in reality more a way of shutting out experience than of receiving it in all its richness.

The infinitesimally small fraction of potential experience which practical perception culls out

for attention is chosen, not for its newness, but for its past association. This type of perception sees only what is familiar. It examines the present with eyes of the past. If something is thrust into consciousness, the mind accommodates itself to the intruding object by perceiving that it is like something known before. Everything novel is repelled or translated into old forms.

Practical perception becomes a routine matter. Nearly all observations needed for the daily processes of life are reduced at a very early age to fixed habits. Nothing new is ever seen unless it is forced on our attention, and then we learn to observe it only by practice and with difficulty. As a result practical perception is always a very stale experience. But this very staleness is what makes it appear so reliable and certain. There is nothing quite so upsetting as an overdose of new experience.

The objects that we recognize as familiar are actually most unfamiliar. We have learned some characteristic mark which serves to indicate their identity, but the chances are that little else has been noticed. Perception has become perfunctory; it stops with the most cursory sort of examination. A person whose mind works only in a practical way finds it impossible to describe the façade of a familiar piece of architecture ex-

cept in the vaguest fashion. But an artist or any trained observer may gain so vivid an impression from a single fleeting glimpse of it that he can draw an accurate sketch of the building.

For the purpose of practical existence, it is fortunate that the labor of perception can be lessened by the short cuts of selection and recognition. We do not have the time or energy to deal sensitively with much of experience. To make our way in the world, we must concentrate on our direct interests. To act decisively and effectively we must ignore irrelevancies. To use a tool we must put our minds on what we are doing with it, not on the instrument itself. The economy and efficiency of practical perception greatly commends it for the executive business of living.

But when we encounter something which we want to know, we have to deal with experience in a different way. Scientific perception undertakes the problem of probing into the nature of things and understanding them. A characteristic of science is its mistrust of the senses and the everyday world which they portray. Science might be described as a way of supplementing the simple report of the senses by the use of powerful instruments. Even though the employment of telescope and spectroscope may ultimately involve the feeble eye of sense, it

nevertheless enables the observer to peer far beyond the range of ordinary vision.

Scientific perception uses a method of dealing with experience which is somewhat different from that of practical perception. Instead of limiting and selecting, it seeks to analyze and organize experience. Its typical procedure is to classify vast numbers of things in certain groups. New experience is not excluded, but is lumped together in convenient compartments according to certain similarities it seems to exhibit. By making these classes sufficiently large, science is able constantly to accommodate an expanding experience. In order to classify, likenesses must be noted and differences ignored. Thus scientific perception is a way of seeing similarity among the crowded objects of experience. It sorts and standardizes all that comes within the range of investigation. The chaos of unrelated things, it orders and catalogues.

After sorting experience, science proceeds to work out rules for dealing with each kind of thing. These rules are usually expressed in mathematical terms. They are generalizations formulated as a result of observing the behavior of a class of similar things. Scientific laws are all particular applications of a general law which asserts that nature is uniform and that it repeats its patterns in endless series.

The result of using instruments, of classifying, of emphasizing similarity, and of applying mathematical law, is to substitute for the seemingly trustworthy and realistic world of practical perception one that is highly abstract. Hard matter flies into atoms and atoms into fields of positive and negative electricity. About all one can perceive in such a world is certain logical relations and mathematical patterns.

Æsthetic perception is more disinterested than the practical type and more naïve than the scientific. It contemplates an object or a group as a whole, without regard to use and without curiosity as to constituent elements. Its function is to appreciate, not to appropriate, or interrogate.

A distinguishing characteristic of æsthetic experience is that it is always unified and harmonious. It does not need to be referred to the past or to be analyzed as does practical or scientific perception. Its unity is immediately perceived without conscious effort on the part of the observer. Its patterns are grasped instantaneously and directly. Æsthetic perception is synthetic sight. To see æsthetically is to see creatively. The objects of such observation are resolved into a single organic composition.

Practical experience consists in recognizing ghosts of the past, whereas æsthetic perception concentrates on the realities of the present. The

latter is a way of actually seeing, not of remembering. As a result it is far more vivid than other experience. And since the past plays little part in it, it is far fresher and more arresting. Æsthetic contemplation is always of a contemporary object, which, no matter how often it has been observed before, is seen again with surprise and wonder.

In æsthetic experience, we enjoy our senses; in other types of perception we use them. Most things that come to our attention are problems to be investigated. We must employ our senses to probe into and examine them. The mind is baffled until it has related them to past experience or found a classification for them. There is a struggle to gain a clear impression. This labor forces us to employ the senses as tools, as means of exploration, so that any delight in their exercise for their own sake, or in their colorful reports, is lost. Pleasure is always a dominant characteristic of æsthetic perception, not only because of its sparkling, sensuous quality, but because it is the one type of experience in which we are quite unthwarted. The parts automatically resolve themselves into intelligible form. There is no riddle to solve, no task of interpretation. And being preoccupied with the impressions of the present we are relieved of all practical virtues of foresight, of scheming for possession,

all memories with their record of circumstances. The intensity of æsthetic interest makes the observer disinterested, at least for an interval.

In all experience, everything that we have encountered before, contributes to our interpretation of what is new. But in practical and scientific experience, reminiscence and recognition play the principal rôles, whereas in æsthetic perception the new elements of the present dominate. Every new practical experience serves to fetter us more firmly to the past. Æsthetic perception tends to liberate the mind from itself and its own stock in trade of worn ideas and judgments.

Whereas science has a deep-seated distrust of the world of appearances, and prefers to substitute for it a mathematical account, æsthetic perception is content with the testimony of eye and ear. Appearance is everything, and the relations back of that appearance count for nothing. Poets are notorious for their vague botany and astronomy though they are particularly concerned with flowers and stars. Great architectural designers have not always been great engineers.

The character of the appearance that appeals to æsthetic perception is its uniqueness, not its similarity to other things. All the qualitative

distinctions of objects delight the artist-observer. He is interested in novelty and discovery, not in association and classification. Poetic metaphor is employed not to show similarity but to build up concrete imagery.

Pure æsthetic experience is rare indeed. Such concentration, such freedom of sense and reason, is constantly interrupted. Only occasionally do we lose ourselves as we gaze on the radiant glass at Chartres or watch the moonlight illumine San Marco at Venice. Usually the stream of experience does not run clear; it is polluted by the flotsam and jetsam of activity, by the heavy sediment of the past.

A Freudian record of a visitor gazing on Saint Thomas' church in New York, that shrine in which Goodhue spoke Gothic as a living language, would probably run something as follows: "This must be the church, Fifty-third Street and Fifth Avenue. What beautiful details, so clearly chiseled! I suppose this has one of the most fashionable congregations in New York. If my arches didn't ache so, I'd like to spend a week strolling around New York streets, there is so much to see. The tower is very low and has no spire at all. I wonder if it's open. That bus is marked Riverside Drive and ought to take me near Grant's Tomb. Why do architects forever design buildings in old styles? That

girl's dress makes her look like a dream, but I can't see her face. You can see nearly everything else though. Sacred architecture certainly is sublime! There is nothing that stirs one quite so much. I oughtn't to want tea so early and if I do have it I mustn't eat anything but cinnamon toast."

This is about as concentrated as are the majority of our æsthetic experiences, one may suspect. For us the artist's world is an occasional glimpse snatched in the midst of our engrossing preoccupations. Few of us see the objects about us. Instead, what we observe are pale ghosts of former experiences. We behold the decaying images of the past in the rich pantomime that goes by. We rarely are aware of what is before us in the fresh and vital terms of the present. We are content to note resemblances reminiscent of old experience, and to deny ourselves the vivid ecstasy of real sight. We are like the stooped proofreader looking over the proofs of a poem, seeing the letters, but not the imagery and beauty before him.

There is no reason, however, why one should prefer the æsthetic interest above the practical or the scientific. Which of these one may choose on a particular occasion will depend on circumstances. The need for deciding between their rival claims arises from the fact that the

mind cannot operate in these three contrasted ways simultaneously without confusing and diluting its impressions.

All experience is potentially æsthetic. The chief sources of æsthetic experience, however, are concrete things of sense—nature, practical art, and fine art. But the appreciation of abstract relations such as those found in mathematics and science is also a form of æsthetic experience. The abstract creations of the scientist have a crystal clarity and sweep of imagination that suggest their author may himself be an artist.

The æsthetic enjoyment of nature depends on the observer's power of perceptual synthesis. The artist is able to see a great deal of experience æsthetically which is not art. Nearly all of us can see the beckoning vista of a country road or the view of a wooded hill in the same æsthetic way in which we would look at a painted landscape. But if we are wondering whether we are on the right road, or if a professional interest in lumber leads us to estimate the stand of trees on the hill, even these familiar views may be merely practical. Or if we have lived all our lives in some tidy hedge-bound country like England or Holland, the road may seem rude and deserted, and the hills uninviting wilderness. Apparently the appreciation of na-

ture, in the æsthetic sense, depends partly on artistic ability and partly on education.

It requires little stretching of the imagination to think of the vista of the winding road, or the view of the wooded hill, as art. For in a very real sense these are man-made. They have become art for us because Wordsworth or Thoreau have educated us to see them æsthetically. We now require no special capacity to enjoy such scenes, though persons to whom they are strange and new would need much creative power to appreciate them. An artist or poet is simply one who can see more experience æsthetically than can other observers. His eye discerns the patterns to which others are blind.

Objects of practical art may give rise to æsthetic enjoyment whenever we are sufficiently detached to see them not as tools but as forms. The eye finds them easy to dwell upon because their human design is written in every line. Nature is often barbaric and uncivilized, but these practical objects, though they may be plain and unimaginative, have been touched by the workman's hand and to some extent humanized. If they appear mechanical and unarresting, it is because their maker has not taken pains to express them in rhythmic line or varied color. They are the skeleton of fine art without its flesh and blood.

A great deal of architecture which is constructed for useful purposes has very little merit in the way of style or design. Yet the eye finds something which is pleasing to contemplate in a commercial city. The very fact that it has been built by human labor and thought may be the basis for this appreciation. As its homely surfaces are touched by smoke and weather, they blend together and hard broken lines are resolved into patterns of beauty.

But fine art is a far richer source of æsthetic appreciation than either nature or practical art. The characteristic of fine art which we perceive with most delight is its originality. It is the invention of a creative artist. This originality is not to be confused with bizarre or exotic exploits which aim merely to attract attention. It is a more daring kind of novelty. For it is born of creative thinking, not from crude or startling experience that has never been refined through reflection.

Probably it is inaccurate to describe most fine art as pure sensuous pleasure. The sensuous pleasure is there largely because the object has been so well conceived that the senses are set free from the drudgery of conducting an investigation. Art is sensuous because it is rational. Or to put it differently, art is the one type of experience which is never a problem. It is the easiest

experience possible for human beings. It never provokes inquiry of itself. In the perception of art, senses and reason are in harmony; both respond to an immediate impression. If we examine and analyze it, we do so, not in an æsthetic spirit, but in a practical or scientific mood.

When under the spell of a great architectural monument, one does not think. The thinking has been done long ago by the architect who assembled this mighty symphony from the quarry. This art demands no effort for the effort has been made. Thinking belongs not to appreciation but to the mind's roving search for knowledge. But the knower perhaps becomes the better worshiper because his curiosity is satisfied and his mind may contemplate in contentment. Knowledge only brings the calm which is necessary to æsthetic enjoyment.

Usually, past and future so occupy us that we enjoy the present only in retrospect. Fine art might be defined as a way of enjoying the present. That is to say, it raises no practical or scientific questions. It affords a kind of experience which is disinterested—which may be enjoyed in its own right. Art encourages not action or thought but contemplation. In a work of art the unremitting sequence of experience finds a peaceful termination. The observer feels no pragmatic interest in the gamble of future

consequences. The past leads to the present and trespasses no further.

The reason that new types of art are difficult to appreciate is because even in æsthetic objects there are usually some elements that are old. In architecture these make up what we call style, while the new elements are those of design. For the other arts the word style is less satisfactory because it is often used to denote an individual manner rather than an accustomed mode of presentation. But however it is designated, in every work of art we find both something familiar and something startlingly new. The familiar presentation enables us to grasp the new interpretation. It is the surprise of finding the new wine in old bottles that intoxicates.

The old elements which make up the style or traditional part of art differ radically from the familiar characteristics of most experience. For the factors in style are all æsthetic, all matters which can be seen or heard. If beheld for the first time they may require a good deal of observation before they are grasped, but they need not be referred to the past for interpretation. The work of art is actually self-explanatory, though we may have to spend a good many hours before the explanation becomes apparent unless we start with a clue to its dominant forms. In relatively simple art, such as ceramics, for ex-

ample, we can grasp with delight something largely exotic. But in complex forms, such as painting or architecture or music, a first impression will hardly resolve them unless we already know the stylistic language.

Art stimulates the imagination because its forms produce vivid memory images which store the mind with colorful materials. Any one may try the experiment of comparing the relative ease of memorizing a bit of representative art and the scene which it depicts. The picture or artistic representation is the easiest to recall. The reason for this is that in art most that is extraneous to the dominant patterns is excluded and those elements which are important to this relationship are heightened. The scene has been unified into something organic which is far easier to recognize than a mere discrete aggregate of things. Once actually observed with concentrated attention, objects of art are extremely difficult to forget. A bit of music, a figure in a painting, the façade of an old building, will often linger in the mind long after the place and circumstance in which they were encountered has faded.

A general condition which art must ever fulfill is to compete successfully with other experience. To gain and hold our roving attention, it must not only equal but actually outdo nature.

The artist must not fall below the standard set by the physical world, and this is by no means a low one. Usually when we say a bit of representative art is not a good portrayal of its object, we do not mean that we prefer a literal copy, but that, by comparison, nature is more interesting than the art. We gauge the merit of any work of art by whether it is more arresting and absorbing to the eye or ear than other objects of experience. Bad art is judged to be inferior precisely because it is so weak that it fails to command attention. Good art is difficult to ignore.

How does the appreciation of architecture differ from the enjoyment of other types of fine art? The majority of writers on architecture from classic times down have found the unique features which differentiate it in its display of sound structure and in its evidence of good workmanship. But the eye is a very superficial judge of structure. The observer's immediate impression takes in little but the spacial relations of the various lines and masses. The grasp of the engineering principles involved in the structure involves scientific, not æsthetic, perception.

When we observe a Gothic building, we do not analyze thrusts and counter thrusts, or the gathering and concentration of forces on piers. We are actually thinking of the dynamic lines

that spring from the clustered columns and are carried to the apex of the ceiling by the ribs of the vaulting. Of the real weight of the vaulting we have little or no conception. In fact its supple lines and curved surfaces give an impression of lightness and unsubstantiality. The analysis of structure is a typically scientific problem that has little to do with the immediate appreciation of æsthetic experience.

Craftsmanship is the other quality supposed to be the distinctive mark of architecture. Nearly any structure which has weathered a century or more exemplifies the virtues of skilled artistry. The workman has mingled his labor without stint in every great architectural monument. Here is a value that is built into every stone and timber. But good workmanship is not confined to architecture alone. It is the universal virtue of all the arts, practical as well as fine. Moreover, essential as skill is to the execution of any creative design, the recognition of skill, apart from its production, depends on a practical judgment. Æsthetic appreciation is content to dwell on the product that is born of craftsmanship but makes no inductions as to the patient process of manufacture.

Of all the non-æsthetic elements in art, the dominant one is technique or skill. Dexterity, virtuosity, workmanship, these are properties not

immediately perceived, but always greatly esteemed and admired. One may guess that for a good many observers this mechanical excellence is a chief appeal. Certainly in architecture much has been written and much is taught about the merits of good craftsmanship, of skilled joinery. These are the qualities which the architect or employer values in the laborer; these are the signs of a good investment to the buyer. In a practical world they are the highest virtue to which labor can attain.

The objection that is raised here to making craftsmanship the differentia of architecture or of any other art is based on the immediacy of the æsthetic perception, the fact that memories of the past have little part in it. The recognition of workmanship involves a judgment which takes into account a deal of former experience, a general acquaintance with the difficulties and means involved in production. It is a typically practical type of judgment. The eye and the ear care little for the means as long as the effect is pleasing. Bad technique will often destroy æsthetic qualities of a performance or other artistic creation, and a comparatively feeble conception may sometimes gain acceptance if excellently presented. Often too, technique is almost inseparably connected with creative ability. But having admitted all this, artistic imagination is

what makes crude or well-executed objects fine art. Technique is æsthetically secondary, however great importance it may have practically.

Yet it would be a mistake to conclude that the sense for workmanship or instrumental mastery is altogether absent from æsthetic appreciation. Both the untrained and the overtrained eye prefer the tight and meticulous drawing of the copyist to the careless expression of the artist. Critics see the brush strokes and miss the strength of an original conception. The precise reader trips over a bit of misplaced punctuation or faulty grammar. Nearly every museum of art contains a certain number of curios, extraordinary little bits of carving in crystal, amazingly wrought pieces of jewelry, or porcelains and glass admirable chiefly because of their size and difficulty in manufacture. These exhibitions of skill are commonly mistaken for creative art which involves invention as well as skill. In architecture what is well built will pass for good design.

The experimental character of original art always precludes perfection in workmanship. When perfection has been reached, generations of patient copying have already reduced it to a routine academic problem. Experimentation is a necessary condition for the creation of anything whatsoever that possesses novelty. In the

masterpiece which we try to set up for an absolute standard there is always a bit of uncertainty, of fortunate groping for the way. The well-schooled pupils of the master will correct this imperfection in their own work, yet theirs will lack precisely the vital daring that makes the original so priceless. Were Cervantes' Don Quixote the finished masterpiece that it is supposed to be, it would have few readers. The condition of mastery is invention and daring, not perfection.

The task of choosing the art which shall be preserved in museum collections for the enlightenment of the public and its posterity must be a baffling one. For in contemporary work, it is the finished and conventional productions which always appear to have the highest excellence, whereas in retrospect we can observe how some courageous experimenter, little appreciated at the time, changed the whole course of progress.

Architecture is so monumental in size that these uncertain innovations and trials of new forms always show with glaring scale. The church of St. Etienne du Mont in Paris may gain in quaintness from the liberties that have been taken in its design, but not infrequently the price of architectural originality is total failure. The dangers that beset the innovator but augment the credit that is due him.

The distinguishing characteristic of architecture among the fine arts lies in its unique function of representing, not human figures, nor natural objects, nor yet pure abstractions of form, but social institutions. It is the sculpture of man's collective life. It expresses organized existence in stone. It is the representative art of the community, of group activity. It is the art form of politics, economics, and sociology. As sciences these are systematic abstractions; as art they are works of architecture.

The functional character of architecture as a tool of stone gives it its differentia which marks it off from all the other arts. This makes it impossible to treat it intelligibly merely in terms of pure art—of materials, style and design. For architecture is an objectification of social behavior. As such it is an index to the patterns of organized human society. Viewed in the present, it is the mechanical body of social enterprise. It is the most concrete data available for the study of the social sciences. It offers them a way of dealing with group behavior objectively.

Building is the visible record of history, the permanent monument of the past. Because of its function of social representation it constitutes the most perfect chronicle. In it we may behold the outward aspect of the medieval or classic worlds as plainly and accurately as if it

were possible to turn the hands of time back to those centuries. The peculiar fabric of these distant periods may still be studied in the architectural forms which expressed them. The interpretation of these past cultures may be based on verifiable material. Buildings have none of the dubious quality of documentary accounts. Here is a part of history itself to witness its own record.

How does architecture resemble the other arts? From the strictly æsthetic point of view it is a composition of three dimensional forms expressed in space. As pure art it is indistinguishable from sculpture. Considered merely in the visual terms of glyptic expression there would be no reason for separating the two, except that the latter deals with pigmy forms and the former with colossal ones. Their real difference lies in the subject matter from which they are derived.

As an art in which line as well as planes and masses trace the designs, architecture is a type of drawing. In so far as it consists in elevations, in flat projections, it is a kind of geometric drafting. Here again the chief distinction is that of size. The fact that it is ultimately drawn in stone instead of on paper or canvas is of secondary importance.

To some degree architecture is akin to paint-

ing. But the use of color which predominates on canvas has never developed to such exuberance in buildings. Usually color is secondary and sculptural mass or line is dominant. One might add that it is a more intellectual art than painting because the formal elements of style and design are stressed more than the sensuous ones of color and tone.

Architecture has frequently been compared with music. Both are formal arts but in entirely different realms and materials. Architecture is a spacial art, music is temporal; the first depends on vision, the second on hearing. Indeed the chief value of comparing the two in poetic metaphor lies in the dramatic nature of the contrast.

Of the space-time arts, architecture is closest to the drama and the dance. These three arts are representative of the organized or collective rhythms of human life. Architecture reflects through lithic form what the drama and the dance portray through groups of human figures. For though it is static, it depicts the scenes or tableaux of human relations. Like architecture, the drama and the dance are also closely related to sculpture in so far as they are interested in cubic form. The design of architecture and of scenery and staging for drama and dance are essentially the same art devoted to different purposes. If architecture may be compared to space-

time art, it is an unspoken drama, a dance without movement.

As history and as a representative art depicting human behavior, architecture has some interests in common with literature. In the concreteness of all its statements it is of course nearest poetry—so also in its rhythmic character. But in so far as it charts social action, it becomes prose. What the eye sees is not greatly different from what the tongue narrates. Social behavior that has been translated into form may be appropriately compared to speech that has become silent words in print.

From the point of view of æsthetic perception a suitable classification of the arts is in terms of space and time. Architecture, sculpture, painting and the decorative arts are dominantly spacial and hence visual. Music, poetry and prose are dominantly temporal, and hence auditory in fact or in derivation. Drama and the dance and some types of music are space-time arts which combine an appeal to both eye and ear.

Art might be defined as matter created in man's own image which is divine form. For form alone is an abstraction, but expressed in materials it gives to them the touch of life.

Looking at architecture in perspective, we recall that its particular task is to depict the imposing grandeur of human institutions. It

sculptures not the image of man in his single weakness, but the monumental form of man united in his efforts to humanize the world. Architecture is a reminder of the price and worth of civilization.

THE END